Number 9, Winter 2003
Editing & Production:
Judith Kennedy
Special thanks to:
David Kirk

BIRD TRENDS

© Elaine M. Dickson

A report on results of national ornithological surveys in Canada

Although the birds of prey are among the largest landbirds, studying raptors is not easy. We still lack basic data on population size and trends for most species. While studies have taken place across Canada, there is no nationally coordinated program to monitor raptor populations, largely because this group of birds falls under provincial jurisdiction in Canada. Efforts to improve raptor monitoring are underway, but until there are enough data from these renewed efforts, much of our information on raptors is generated by work on species at risk. This issue of *Bird Trends* summarizes some recent studies of this group of birds, but many questions about the status of raptors in Canada remain, for now, unanswered.

Inside:

Raptor population trends	9
Raptors at risk	12
Species accounts	16
Owl monitoring	40
Status of peregrines	52
Volunteer program menu	66

***Bird Trends* is available on-line at:**
http://www.cws-scf.ec.gc.ca/birds/news/index_e.cfm

Overview of raptor status and conservation in Canada

David A. Kirk, Aquila Applied Ecologists, Box 87, Carlsbad Springs, Ontario K0A 1K0; David.Kirk1@sympatico.ca

Introduction

The impact of human activity on ecosystems is increasingly complex and the effects are often cumulative. Urbanization, forestry, agriculture, and the energy sector are reducing or fragmenting certain habitat types with attendant changes in biodiversity. In addition, recent global climate change is affecting the reproduction of some bird species (e.g., earlier spring migration [Bradley *et al.* 1999], or egg-laying dates [Brown et *al.* 1999]), and is predicted to have profound and far-reaching effects, particularly in northern countries like Canada (Hughes 2000). Environmental changes are now so extensive that it is necessary to measure their impacts on biodiversity at regional or even continental levels.

Raptors were discovered to be useful 'indicators' of environmental health (Caro and O'Doherty 1999) during the 1960s. Research into the drastic population declines in bird- and fish-eating raptors, such as Peregrine Falcons (*Falco peregrinus*), and Osprey (*Pandion haliaetus*) revealed that eggshell-thinning and reproductive failure were caused by organochlorine pesticides. While most raptor populations have recovered from these population declines in recent times (Osprey populations in the Great Lakes Region have re-bounded dramatically, for example; Kirk and Hyslop 1998), this group remains susceptible to contemporary environmental threats like habitat loss or fragmentation, and climate change. Because raptors are long-lived birds with large area requirements, they may be good indicators of such large-scale changes through measurable affects on their reproduction and territory occupancy (Newton 1979). Research to determine the significance of these landscape-level changes, and the means to mitigate detrimental effects, may be the most pressing needs for this group of birds.

Monitoring raptors

Because the information we have on population trends in raptors is incomplete, an effort to identify the best techniques and most efficient approaches for long-term

monitoring of this group of species is underway. Known as the North American Raptor Monitoring Strategy, it consists of individual species accounts that assess the effectiveness of current monitoring methods in different geographic areas and seasons, and provides recommendations for general and specific improvements in study design, sampling, and data analysis. Ultimately, the North American Raptor Monitoring Strategy will provide a sound scientific and statistical basis for monitoring raptor populations based on comprehensive, up-to-date information. A national owl monitoring protocol was also recently developed (see Takats Priestley p. 40) to standardize methodology and allow comparisons across regions and between surveys.

Summaries of studies done across Canada indicate that we know most about raptor population trends for species usually associated with open habitats (Kirk and Hyslop 1998). In fact, some raptor species have been described as 'phantoms of the forest' (e.g., the accipiters and forest-dwelling buteos). They are secretive or nocturnal, occur at low densities and/or in remote, inaccessible regions (e.g., the northern boreal forest). Even for some of the best-studied species, evaluating population changes is fraught with difficulties because geographical variation in the prey base and population cycles affect breeding densities, population numbers, and movements of individuals (see Doyle p. 24, and Sherrington p. 34). These marked geographical differences in ecology mean we cannot always extrapolate from the population status in one region and apply it to another.

For these reasons, it is critical that data gathered on raptors are both long-term and multi-scale. Of paramount importance is the need for data-sharing so that multiple datasets can be examined at different scales. The typically fluctuating population levels associated with large birds like raptors mean we need to know the 'natural' magnitude of high and low levels. For example, the recent dramatic reduction in peregrine productivity in some northern populations (see Mossop p. 62, and Brazil p. 56), or recent declines in Ferruginous Hawk (*Buteo regalis*) productivity (see Stepnisky *et al.* p. 31), may be an example of a 'natural' population cycle or they may represent something more ominous – a long-term population decline. However, in such long-lived species, decreased productivity may not translate into a population decline, and variation of up to 15% is considered acceptable in many species (Newton 1979).

Few rigorous statistical analyses have been conducted on hawk migration count data or the nocturnal owl survey, largely because these programs have not yet collected a sufficient time series of data for analysis. We still lack data on many widely distributed species characteristic of Canadian habitat (e.g., Boreal Owl [*Aegolius funereus*] and Northern Goshawk [*Accipiter gentilis*]). Historically, it has been difficult to secure long-term funding and commitment to survey raptors in remote regions which hampers the development of effective monitoring programs. Through the North American Bird Conservation Initiative, a coordinated effort to maintain the diversity and abundance of the continent's birds (see http://www.cws-scf.ec.gc.ca/birds/nabci_e.cfm), we may be able to address some of the ongoing needs for improved raptor monitoring, research and conservation.

Learn more about the North American Raptor Monitoring Strategy at: (http://srfs.boisestate.edu/narms1.htm).

Figure 1. Canadian Bird Conservation Regions.

Raptor conservation

The focus of modern conservation biology has shifted away from individual species conservation to conservation of communities and the ecosystems upon which they depend (Simberloff 1998). One method of identifying habitats and suites of bird species requiring conservation is the Partners in Flight (PIF) species assessment scheme. By scoring seven criteria for each species, we can identify those that need immediate conservation action, and those that require additional research or monitoring. This approach will enable us to begin conservation *before* species become critically endangered. The aim of Partners in Flight is to help us maintain a representative diversity of avifauna in all ecoregions of Canada, including species for which Canada harbours the majority of their population or habitat. This encompasses many arctic and boreal raptor species such as Gyrfalcon (*Falco rusticolus*), Tundra Peregrine Falcon (*F. p. tundrius*), Snowy Owl (*Nyctea scandiaca*), Northern Hawk Owl (*Surnia ulula*) and Boreal Owl (*Aegolius funereus*) for which we have limited population trend information. More information on the PIF species assessment scheme is available at: http://www.rmbo.org/pif/pitdb.html.

We also need comprehensive monitoring programs to help us determine whether our conservation efforts are working by getting us closer to population objectives. These objectives must be set in a landscape context to manage conflicting habitat needs of priority species. For example, Barred Owls (*Strix varia*) become rare when forest cover falls below about 70% of the landscape, but open-country raptors, like Northern Harrier (*Circus cyaneus*) and American Kestrel (*Falco sparverius*), disappear when forest cover exceeds about 50% of the landscape (Grossman and Hannon 2001). It will be a challenge to conserve all of Canada's raptors, and our approach will have to evolve as new monitoring and research information sheds light on their status.

Regional summaries

The following summaries are meant to provide a brief overview of raptor population status and trends. A list of raptors of potential concern was generated from the PIF species assessment process (http://www.rmbo.org/pif/pitdb.html) by Bird Conservation Region (BCR; Fig. 1). Although this process is incomplete, a preliminary list is presented in Table 1 for general information. Specifics on the conservation status of Canadian raptors will

Table 1. Preliminary list of raptors of high conservation concern in Canadian Bird Conservation Regions (BCRs) using the Partners in Flight species assessment process.

Species	BCR3	BCR4	BCR5	BCR6	BCR9	BCR10	BCR11	BCR12	BCR13	BCR14	Total BCRs
Bald Eagle			X								1
Northern Harrier				X	X		X	X	X		5
Sharp-shinned Hawk				X					X		2
Cooper's Hawk			X								1
Northern Goshawk		X		X		X					3
Swainson's Hawk				X	X	X	X				4
Ferruginous Hawk					X	X	X				3
Golden Eagle					X						1
American Kestrel									X		1
Merlin				X							1
Peregrine	X		X	X	X		X	X			6
Gyrfalcon	X	X				X					3
Prairie Falcon					X	X					2
Flammulated Owl			X		X	X					3
Western Screech-Owl			X								1
Snowy Owl	X										1
Northern Hawk Owl				X							1
Northern Pygmy-Owl			X								1
Burrowing Owl							X				1
Northern Spotted Owl			X		X						2
Short-eared Owl	X	X		X	X	X	X		X	X	8
Boreal Owl		X									1

NB - BCRs 7 and 8 had no raptors with high scores, but this is likely due to a lack of data or incomplete assessment in these regions.

BCR 3 = Arctic Plains and Mountains
BCR 4 = Northwestern Interior Forest
BCR5 = Northern Pacific Rainforest
BCR6 = Boreal Taiga Plains
BCR 7 = Taiga Shield and Hudson Plains
BCR 8 = Boreal Softwood Shield
BCR 9 = Great Basin
BCR 10 = Northern Rockies
BCR 11 = Prairie Potholes
BCR 12 = Boreal Hardwood Transition
BCR 13 = Lower Great Lakes and St. Lawrence Plain
BCR 14 = Atlantic Northern Forest

be included in PIF landbird conservation plans for each BCR.

Regional summaries suggest that some raptor populations might not be faring as well as previously thought (Kirk and Hyslop 1998). To achieve raptor conservation in light of the current lack of information the precautionary principle must be applied.

British Columbia and the Yukon

This region includes BCRs 3 (Arctic Plains and Mountains), 4 (Northwestern Interior Forest), 5 (Northern Pacific Rainforest), 6 (Boreal Taiga Plains), 9 (Great Basin), and 10 (Northern Rockies).

Probably the most important human activity affecting raptor populations in much of this region is timber harvest, and in particular harvest of old growth forests upon which many species depend. Of critical importance is the dramatic population decline of the Northern Spotted Owl. It is now estimated that only 25 pairs occur in British Columbia and the overall rate of decrease was recently estimated at 44% or –6.85% per annum (Blackburn *et al.* 2001). Unless critical habitat occupied by breeding pairs is protected, this species is destined for extirpation in BC within a few years. Given a historical maximum estimate of 500 pairs in BC, the impending loss of this northern component represents a substantial loss to the Spotted Owl population.

Over the long-term it is essential that landscape-level forest management plans be geared towards maintaining biodiversity, and ensuring viable populations of forest species of concern such as the Northern Goshawk (see Doyle p. 24, and McClaren p. 26) and Flammulated Owl (*Otus flammeolus*; see van Woudenberg p. 45) so that they do not fall to the critically low and non-viable population levels of the Northern Spotted Owl. We still lack information on local and landscape level requirements of forest raptors, which limit our ability to provide the concrete information needed by forest managers.

Another detrimental effect of human activity in this region is the introduction of mammalian predators on islands off the west coast of BC (BCR 5), and their subsequent effects on prey populations (e.g., the seabird prey of Peale's peregrine (*F. p. pealei*). Several species are of concern because very little is known about their population status and trends; the Western Screech-Owl (*Otus kennicotti*) is thought to be declining. Little is known of the status of the Queen Charlotte Island Goshawk (*A. g. laingi*) (see McClaren p. 26) or the Queen Charlotte Island race of the Northern Saw-whet Owl (*Aegolius acadicus brooksi*). Both have small populations and both subspecies depend on old or mature forests. Peale's Peregrine (listed as "Special Concern" by COSEWIC; see Rothfels p. 12) has also declined from historical levels.

In the southern part of this region, agriculture and urbanization, as well as industrial development, may pose threats to certain raptor populations, while they may provide habitat for others.

While raptor populations in the northern part of this region are removed from many human activities, they may still be vulnerable to pesticides and changes in climate. Breeding failures in northern Peregrine Falcon populations in the Yukon over the last few years may be an ominous reminder that apparent remoteness does not protect raptors from human influences (see Mossop p. 62).

Northwest Territories and Nunavut

This region includes BCRs 3 (Arctic Plains and Mountains), 4 (Northwestern Interior Forest), 6 (Boreal Taiga Plains) and 7 (Taiga Shield and Hudson Plains).

Two points are important about this region: it is the region most likely to be affected by climate change and airborne contaminants (such as persistent organic pollutants), and it is globally important for raptor populations. Diamond mining and oil and gas operations are increasing, and these may pose threats to raptor populations.

Although this issue features Peregrine Falcon information from this region (see Carrière *et al.* p. 57), there are many other species in the Arctic for which Canada has

high jurisdictional responsibility. Snowy Owl, Rough-legged Hawk (*Buteo lagopus*), and Gyrfalcon have a large component of their global population or range here.

Unfortunately, very little information exists for these populations. Gyrfalcon monitoring was halted due to a lack of on-going funding. One source of information on Rough-legged Hawks comes from hawk migration counts; an update on western hawk monitoring sites will soon be published (Jeff Smith pers. comm.; http://www.hawkwatch.org/). Because these populations exhibit cyclic fluctuations in their reproduction or breeding densities in response to prey availability, long time series of data and complex statistical analyses are needed to interpret population status. Some of the long-term data sets available (e.g., Gyrfalcon at Hope Bay, and peregrine at Rankin Inlet) were obtained as by-products of short-term studies; although opportunistic data collection has greatly contributed to our knowledge in this region, a consistent monitoring program would provide the best information, and enhance our ability to detect the effects of climate change.

Kimbyd Scuba © OMNR

Prairie Provinces Grasslands

This region corresponds to BCR 11 (Prairie Potholes). Habitat loss and fragmentation of native prairie grassland continue to pose problems for prairie raptor species and special land management is required to ensure their survival. Low-input farming that limits synthetic fertilizers and pesticides that are potentially harmful to raptors and their prey may reduce these threats. Encouraging the retention of natural habitats (native prairie, wetlands, prairie sloughs) may also have benefits for these species.

In the prairies, populations of Red-tailed Hawks (*Buteo jamaicensis*) increased with the planting of aspen shelterbelts (Houston and Bechard 1983), while Ferruginous Hawks declined because of the conversion of native grassland to cropland (Schmutz 1989). Planting trees in the prairies has provided nest sites for Swainson's Hawks (*Buteo swainsoni*) but may have increased predation on Burrowing Owls (*Athene cunicularia*), populations of which may no longer be viable (Holroyd *et al.* 2001; see Shyry p. 47).

Swainson's Hawk populationshave experienced long-term declines in productivity. Massive mortality from secondary poisoning by grasshopper insecticides occurred on its Argentinian wintering grounds in the late 1990s. Such mortality may add to factors in the breeding areas although declines appear to be confined to the grasslands. The reasons declines do not extend to the parklands (see Houston p. 29) are unclear (Schmutz *et al.* 2001). Richardson's ground squirrel (*Spermophilus richardsonii*), a primary prey item in both areas, has declined drastically in the grassland region coincident with increased agricultural intensification, as are declines in grassland birds in general.

Boreal forest

This region corresponds to part of BCR 6 (Boreal Taiga Plains), as well as BCR 7 (Taiga Shield and Hudson Plains), and BCR 8 (Boreal Softwood Shield). Priority lists of raptors and other species have not yet been completed for BCRs 7 and 8.

Many human influences affect raptor populations in the boreal forest, including climate change, timber harvest, seismic lines, and oil and gas development. Humans have also influenced fire cycles (through fire suppression) and insect outbreaks (from resulting changes in tree species composition, as well as direct insect control).

Like the arctic region, the boreal forest is of global importance. Perhaps the main conservation concern for raptors in the boreal forest is the effect of timber harvest on tree species composition, age structure, and landscape-level forest cover. While some species use clear-cuts extensively for foraging (e.g., American Kestrel [*Falco sparverius*] and Northern Hawk Owl [*Surnia ulula*]; Duncan and Duncan 1998), this represents habitat loss for other species. Generally timber harvest is likely to reduce the overall area and increase fragmentation of old mixed-wood forests, preferred by

habitat specialists such as the Barred Owl (*Strix varia*) and Boreal Owl (*Aegolius funereus*). Because the cutting rotation for some tree species is 60 years or less, a decline in the average age of forest stands might occur over time. The main nesting trees (balsam poplar [*Populus balsamea*]) for species such as the Barred Owl will be confined to creek bottoms which are currently off-limit to cutting in Alberta.

The habitat effects of oil and gas development, linear road disturbance, hunting pressure, forestry, and recreation are increasing in the boreal forest with potential implications for raptors. Some species require a specific landscape structure and configuration for survival; Great Gray Owls (*Strix nebulosa*) need patches of old growth forest for nesting, interspersed with young forest adjacent to boggy meadows for foraging. If either component disappears at the landscape scale, this may negatively affect Great Gray Owl populations (Kirk and Duncan 1996). This highlights the need to maintain a natural range of variability throughout the forested landscape.

Other species require large stands of mature to over-mature timber. Losses of aspen parkland habitat in Alberta due to agriculture and forestry have caused the virtual disappearance of Broad-winged Hawks (*Buteo platypterus*) in this region, and the species may not be faring well in the southern boreal mixed-wood zone which is under heavy pressure from logging by pulp and paper companies. A project to search for boreal species in 'pristine' forest in Alberta, as part of the second breeding bird atlas, found no nests and sighted less than six Broad-winged Hawks. Similarly, while the Northern Goshawk is found in both the parkland and boreal, it requires extensive tracts of mature or over-mature forest; liquidation harvest of timber on private land in north-central Alberta poses a threat to the prime nesting habitat of this species.

Unfortunately, because of its remoteness, most of the boreal region is poorly covered by existing avian surveys so it is particularly hard to track changes. While the nocturnal owl survey provides some information on northern forest owls, most datasets cover too short a period to assess the significance of population trends, and are only able to document year-to-year changes due to changing prey populations. In terms of diurnal raptors in the boreal forest, the major challenge is to find ways to monitor populations of accipiters and buteos (such as Sharp-shinned Hawk [*Accipiter striatus*] and Broad-winged Hawk).

Ontario

Four BCRs occur in Ontario; BCR 7 (Taiga Shield and Hudson Plains), 8 (Boreal Softwood Shield), 12 (Boreal Hardwood Transition) and 13 (Lower Great Lakes/ St. Lawrence Plain).

Populations of some raptor species requiring extensive forest cover (e.g., Red-shouldered Hawk [*Buteo lineatus*]) in southern Ontario are a fraction of their historical numbers. Forest clearance for agriculture, urbanization and industrial development has been extensive, especially in the Carolinian region; the patches of forest that remain there are small and isolated. This has augmented numbers of some species (e.g., Great Horned Owl [*Bubo virginianus*]), which thrive in highly fragmented landscapes.

While special surveys for species such as Red-shouldered Hawk indicate that populations are stable or increasing in Ontario, this is likely because this species has reached equilibrium with available forest cover and fragmentation. It is doubtful whether the species could ever return to its higher historical levels. In highly altered landscapes such as BCR 13, it will be vital to conserve existing natural habitat.

In BCR 12, forest management could have an important effect on raptor populations, but little systematic monitoring of local and landscape-level effects of timber harvest has taken place in this region. Because data from the nocturnal owl survey are only available for a short period, they are not yet able to evaluate the significance of trends which simply reflect short-term changes in food abundance (see Badzinski p. 17).

Several raptor species associated with aquatic ecosystems declined in the 1960s and 1970s because of pesticides and other

contaminants in the Great Lakes. Bald Eagles (*Haliaeetus leucocephalus*) have since increased in numbers, although metal poisoning may still be a problem for pairs breeding in the southern Great Lakes region (see Badzinski p. 19).

Most raptor species in Ontario seem to be doing fairly well, but adequate monitoring has really only taken place in the southern and central part of the province.

Quebec

Quebec is comprised of six BCRs; BCR 3 (Arctic Plains and Mountains), 7 (Taiga Shield and Hudson Plains), 8 (Boreal Softwood Shield), 12 (Boreal Hardwood Transition), 13 (Lower Great Lakes/ St. Lawrence Plain), and 14 (Atlantic Northern Forest).

Little information exists on recent trends in raptors in Quebec. This, in part, reflects the remoteness of much of the region which makes it logistically difficult to survey birds. In both Ontario and Quebec, the main land use activities affecting raptors are agriculture, forestry, urbanization and industry. Agricultural intensification, including drainage of wetlands and removal of woodlots, as well as practices such as pesticide use, may affect raptor populations. Changes in farming systems, such as a switch from mixed livestock and cropping to monoculture rowcrops, may also affect some species; for example, American Kestrel may be declining because of loss of pasture. In northern regions, forest harvesting is changing spatial patterns of forest age distributions, tree species composition and fragmentation patterns. While this may be beneficial for some species (e.g., Northern Hawk Owl or American Kestrel), it may be detrimental for others (e.g., Barred Owl or Boreal Owl). Hydro-electric dams in northern Ontario and Quebec may displace some raptor species as flooding causes permanent forest loss; this could have cumulative effects on raptors.

In the future, migration data from the Tadoussac Bird Observatory may provide an important source of information on raptor populations in Quebec (see Ibarzabal p. 39). Because the current run of data is short, analyses cannot yet detect any trends in raptors. However, the Études des populations d'Oiseaux du Québec (ÉPOQ) check-list survey does provide useful information on raptors and other bird species. While no recent statistical analyses have been undertaken, the following general results (J. Larivée, pers. comm.) will provide an indication of raptor trends in Quebec.

Of the 15 diurnal raptors for which results were available (1980–2001), only two showed signs of a decrease; the Osprey decreased from 14.6% frequency of occurrence in 1980 to 7.4% in 2001, and American Kestrel decreased from 20.8% to 18%. ÉPOQ is considered to be a reliable indicator of declining populations (Dunn *et al.* 1996).

The increase in many species is likely due to their recovery following the ban on DDT in the early 1970s and, to a lesser extent, a combination of expanded coverage of the province by ÉPOQ and increases in numbers of observers and observer effort. For example, the apparent slow increase in Golden Eagles may be related to observer effort, but the steady increase in Sharp-shinned Hawk sightings (from 5.2% in 1980 to 9.2% in 2001) is correlated to the increasing number of bird feeders, and a strong increase in Mourning Dove numbers. Increases detected by ÉPOQ include Turkey Vulture (from 2.0% in 1991 to 10% in 2001), Bald Eagle (from 0.1% in 1980 to 3.5% in 2001) and Peregrine Falcon (from 1.2% in 1980 to 2.9% in 2001).

Although Northern Goshawk showed an increase of 1% per year from 1980-2001, this appears to reflect the growth portion of this species' 10-year population cycle; the population low occurred from 1986-1990, with the peak in 1999. ÉPOQ also showed signs of a population cycle in Rough-legged Hawk (with lows in 1985, 1988, 1995 and 1998 and peaks in 1987, 1992, 1996 and 2000) that probably reflects cyclical changes in food supply. No apparent change occurred in Northern Harrier or Merlin populations.

Separate analyses of the ÉPOQ data to differentiate raptor population trends in the north of Quebec (north of 47°N) from those

in the south (between 45°N and 47°N) show very interesting differences. Five main patterns are apparent:

1) populations increasing in both the north and south at similar rates (Turkey Vulture);
2) populations increasing in the north but stable or slightly increasing in the south (Bald Eagle, Northern Goshawk, Sharp-shinned Hawk, Golden Eagle, Peregrine Falcon);
3) populations increasing and more abundant in the south, and no change in the much lower population levels in the north (Cooper's Hawk);
4) populations increasing and more abundant in the south, and much lower populations increasing less markedly in the north (Red-shouldered Hawk); and
5) populations declining in the south, and increasing or stable in the north (American Kestrel, Northern Harrier).

Some exceptions occurred, most notably for Red-tailed Hawk where abundance was similar in north and south, but a recent increase in northern populations was detected. ÉPOQ data also allow the tracking of species that are expanding their ranges. For example, the Turkey Vulture has always been more abundant in the south, but ÉPOQ data indicate that it began to invade northern Quebec in the early 1990s and that the current rate of increase in the north and the south is similar.

The decline in American Kestrel was very pronounced in southern Quebec, especially over the last ten years, whereas the trend in the north has been positive over the last seven years. It is possible that declines in the south are related to changes in agriculture (loss of pasture or pesticide use) while in the north, clear-cuts created by timber harvest may have increased suitable habitat.

Various biases of coverage can also be examined easily using ÉPOQ data; the overall positive trend in Bald Eagle populations is due to the apparently increasing northern population, whereas there is little change in the south. It could be argued that counts from two hawkwatches (Tadoussac and Observatoire Raoul-Roy at Saint-Fabien) where intensive observations began in the 1990s, could strongly bias these northern counts. However, removing the checklists from these hawkwatches had little affect on the pattern of population change. These results demonstrate that the ÉPOQ data certainly merit extensive further statistical investigation and discussion.

Atlantic Provinces

Two of the four BCRs in the Atlantic Region are predominantly forested (BCR 8, Boreal Softwood Shield and 14, Atlantic Northern Forest; New Brunswick is 85% forested) [Labrador's BCRs 3, Arctic Plains and Mountains and 7, Taiga Shield and Hudson Plains are not forested]. As in other regions, timber harvest is altering the composition and distribution of various forest habitats. The supply of older forests in New Brunswick is being reduced through forest harvesting (N.B. Dept. Nat. Res. 1995), and the proportion of hardwood is increasing at the expense of softwoods.

While New Brunswick has implemented guidelines to maintain minimum areas of old forest habitats (N.B. Dept. Nat. Res. 2000), the impact of the above changes on forest raptors is poorly understood. Efforts to refine the guidelines for supply, spatial configuration and definition of old habitats are being undertaken in conjunction with monitoring of some of the raptor species affected. Both the Nocturnal Owl Survey and the Forest Hawk Survey were initiated in the Maritimes for this purpose.

Other than Peregrine Falcon surveys in Newfoundland and Labrador (see Brazil p. 56), few long-term raptor monitoring programs occur in this region. Barred Owls have been studied to some extent through a nest box program in Nova Scotia, as well as a nest project in two New Brunswick study areas. There have also been some attempts by naturalists and birders, like Stuart Tingley and Brian Dalzell, to find and conduct counts of migrating raptors at concentration points such as heights of land and coastlines.

Bald Eagles and Osprey have increased in abundance in the Maritimes to the point where the Osprey was removed from the

New Brunswick Endangered Species list in 1996. In recent years, new raptor species have been confirmed as breeding species in Atlantic Canada: seven Cooper's Hawk and three Red-shouldered Hawk nests were documented in New Brunswick (1998–2001). In 2001, Red-shouldered Hawks were observed on three of ten transects in southwestern New Brunswick, and Northern Hawk Owls were found nesting in Cape Breton in the late 1990s (Lauff 1997). This may indicate that populations of these species are expanding into the region.

Acknowledgements

Thanks to Ursula Banasch, Suzanne Carrière, Gordon Court, Geoff Holroyd, Stuart Houston, Judith Kennedy, Jacques Larivée, Scott Makepeace and Dave Stepnisky for their valuable comments on earlier drafts of this overview.

References

Blackburn, I.R., A.S. Harestad, J.N.M. Smith, S. Goodwin, B. Hentze, and C.B. Lenihan. 2001. *Population assessment of the Northern Spotted Owl in British Columbia 1992-2001.* Ministry of Water Land and Air Protection. http://wlapwww.gov.bc.ca/wld/documents/spowtrend_1992-2001.pdf.

Bradley, N.L., A.C. Leopold, J. Ross and W. Huffaker. 1999. *Phenological changes reflect climate change in Wisconsin.* Proceedings of the National Academy of Sciences 96: 9701-9704.

Brown, J.L., S-H. Li and N. Bhagarbati. 1999. *Long-term trend toward earlier breeding in an American bird: a response to global warming?* Proceedings of the National Academy of Sciences 96: 5565-5569.

Caro, T.M., and G. O'Doherty. 1999. *On the use of surrogate species in conservation biology.* Conservation Biology 13: 805-814.

Duncan, J.R., and P.A. Duncan. 1998. *Northern Hawk Owl* Surnia ulula *in* "The Birds of North America, No. 356" (A. Poole and F. Gill, eds). The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C.

Dunn, E., J. Larivée, and A. Cyr. 1996. *Can Checklist Programs Be Used to Monitor Populations of Birds Recorded During the Migration Season?* Wilson Bull. 108(3):540-549.

Grossman, S. and S. Hannon. 2001. *Raptor responses to landscape level changes in habitat characteristics in the aspen parkland of central Alberta.* Abstracts, Raptor Research Foundation meeting, Winnipeg, October 2001.

Houston, C.S. and M.J. Bechard. 1983. *Trees and the Red-tailed Hawk in southern Saskatchewan.* Blue Jay 41: 99-109.

Hughes, L. 2000. *Biological consequences of global warming: is the signal already apparent?* Trends in Ecology and Evolution 15: 56-61.

Kirk, D.A. and J. Duncan. 1996. *Update report on the status of the Great Gray Owl in Canada.* COSEWIC, Ottawa.

Kirk, D.A., and C. Hyslop. 1998. *Population status and recent trends in Canadian raptors: a review.* Biological Conservation 83: 91-118.

Lauff, R.F. 1997. *Range expansion of Northern Hawk Owls* (Surnia ulula) *and Boreal Owls* (Aegolius funereus) *in Nova Scotia.* Pp. 569-571 *In* "Biology and Conservation of the Owls of the Northern Hemisphere" (J.R. Duncan, D.H. Johnson and T.H. Nicholls, eds.). USDA Forest Service Gen. Tech. Rep. NC-190.

New Brunswick Dept. Natural Resources and Energy. 1995. *Management of Forest Habitat in New Brunswick.* Unpub. Rep., New Brunswick Dept. Natural Resources and Energy: 40 p.

New Brunswick Dept. Natural Resources and Energy. 2000. *A Vision for New Brunswick forests: goals and objectives for Crown land management.* New Brunswick Dept. Natural Resources and Energy: iii + 44 p. http://www.gnb.ca/0078/vision.htm.

Newton, I. 1979. *Population ecology of raptors.* Buteo Books, Vermillion, SD.

Schmutz, J. K. 1989. *Hawk occupancy of disturbed grasslands in relation to models of habitat selection.* Condor 91: 362-371.

Schmutz, J.K., C.S. Houston, and S.J. Barry. 2001. *Prey and reproduction in a metapopulation decline among Swainson's Hawks,* Buteo swainsoni. Canadian Field-Naturalist 115: 257-273.

Simberloff, D. 1998. *Flagships, umbrellas, and keystones: is single-species management passé in the landscape era?* Biological Conservation 83: 247-257.

Population trends in raptors from the Breeding Bird Survey

C.M. Downes, CWS National Wildlife Research Centre, Ottawa, ON K1A 0H3; Connie.Downes@ec.gc.ca

The North American Breeding Bird Survey (BBS) is a large-scale avian survey program initiated in 1966 to monitor the status and trends of breeding bird populations across the United States and Canada. The BBS consists of randomly selected, 40-km routes established along roadsides that are surveyed once annually by skilled volunteers and professional biologists. BBS routes are not ideal for surveying raptors as the routes are concentrated in southern Canada resulting in poor coverage of this group's boreal and arctic ranges. Furthermore, raptor species that breed before June (when the survey takes place) or that are nocturnal, secretive or widely dispersed are not well-sampled by the BBS. However, despite these deficiencies, the BBS is still considered a useful source of information on raptor trends, and, in the past, the results have been shown to be consistent with trends from other survey methodologies (e.g. Kirk and Hyslop 1998).

Table 2. Summary of Breeding Bird Survey trends for raptors for Canada, and by Bird Conservation Region.

Species / Area	First year - 2000 Trend	P	N	1971-1980 Trend	P	N	1981-1990 Trend	P	N	1991-2000 Trend	P	N
Turkey Vulture												
Canada	12.5	*	68				17.9		23	-5.8		60
Boreal Hardwood Transition	16.0		24							2.5		21
Lower Great Lakes/St. Lawrence Plain	10.8	n	32							-11.1		29
Osprey												
Canada	0.3		105	-4.7		30	-6.9		38	6.8		68
Northern Rockies	-2.9		23									
Atlantic Northern Forest	-1.4		40	-4.9		18	-1.6		21	-4.4		26
Bald Eagle												
Canada	2.2		68				2.9		16	1.7		54
Northern Pacific Rainforest	4.8		21							-2.5		16
Northern Harrier												
Canada	-4.6	*	282	-0.9		100	-7.1	*	118	-2.9		183
Boreal Taiga Plains	-10.0	*	45				-12.3	n	19	-4.2		27
Prairie Potholes	-3.6	n	116	-1.3		46	-3.3		45	-0.9		86
Boreal Hardwood Transition	0.0		23									
Lower Great Lakes / St. Lawrence Plain	-3.4		50	7.4		24	3.9	n	18	-14.0	*	36
Atlantic Northern Forest	6.8		35				-0.9		18	-0.7		18
Sharp-shinned Hawk												
Canada	10.6		48							-2.0		23
Cooper's Hawk												
Canada	-7.0		31									
Northern Goshawk												
Canada	-2.6		15									
Red-shouldered Hawk												
Canada	4.6		21									
Broad-winged Hawk												
Canada	3.9	*	100	8.7		27	-6.5		33	7.2		42
Boreal Hardwood Transition	2.3		44	18.8		18	-3.5		16	12.0	*	21
Atlantic Northern Forest	3.6		24									
Swainson's Hawk												
Canada	-1.2		121	4.0		39	-0.7		51	-7.1	*	84
Prairie Potholes	-2.4		107	6.2	n	38	-2.5		47	-6.8	*	78
Red-tailed Hawk												
Canada	2.6	n	349	-5.1	n	93	1.4		142	1.5		272
Boreal Taiga Plains	0.3		74				-3.5		34	3.8		62
Great Basin	10.7	n	20							3.9		17
Northern Rockies	5.3		30							6.4		25
Prairie Potholes	4.2	*	103	-4.5		32	0.1		44	1.3		88
Boreal Hardwood Transition	0.3		21							2.1		17
Lower Great Lakes / St. Lawrence Plain	-5.6	*	47	0.2		19	3.0		21	-13.3	*	34
Atlantic Northern Forest	5.4		24									
Ferruginous Hawk												
Canada	5.0		25							-6.0		18
Prairie Potholes	-0.3		25							-0.8	*	18
American Kestrel												
Canada	0.6		383	8.1	n	156	-1.0		170	0.6		271
Boreal Taiga Plains	3.9		69	-4.2		21	13.0	*	28	7.0	*	55
Boreal Softwood Shield	-6.2	*	23	-5.3		16						
Great Basin	6.6		21							-7.9		15
Northern Rockies	1.9		30	11.1	*	18	-15.5		16	3.8		23
Prairie Potholes	2.1		66	14.7		19	-1.0		28	-1.9		47
Boreal Hardwood Transition	-0.9		55	15.8	*	21	0.7		26	-3.3		38
Lower Great Lakes / St. Lawrence Plain	2.0		62	14.8		33	-5.6		32	-5.0		47
Atlantic Northern Forest	1.0		54	4.0		20	-3.8		24	8.1		31
Merlin												
Canada	2.7		85							3.1	*	57
Boreal Taiga Plains	-0.3		23							4.7	*	17
Prairie Potholes	10.8		30							9.5	*	20
Great Horned Owl												
Canada	-5.6	*	133	17.6		32	-4.6	*	59	4.8		64
Boreal Taiga Plains	-18.9	*	31				-30.9		17			
Prairie Potholes	4.1	n	68				9.5		30	8.6		39
Lower Great Lakes / St. Lawrence Plain	-7.9		15									
Barred Owl												
Canada	-2.1		24									
Atlantic Northern Forest	-2.1		16									
Short-eared Owl												
Canada	-20.7		35									
Prairie Potholes	-23.1		26									

"Trend" is the mean annual percent change in bird populations. "N" is the total number of routes used to calculate the trends. "P" gives the statistical significance of the trend (* = $P<0.05$, n = $0.05<P<0.15$). The first column shows trends for the whole period of coverage: trends were calculated for the period 1967–2000 for Canada and the Atlantic Northern Forest and 1969-2000 for all other Bird Conservation Regions. The other three columns show trends in each of the most recent three decades.

Trends are reported only for those species and regions that had data from a minimum of 14 BBS routes and 40 individuals (Table 2). Trends with sample sizes close to this minimum should, therefore, be interpreted with caution.

When BBS results were pooled for the whole of Canada (up to the year 2000) there was sufficient information to calculate long-term trends for 14 species of diurnal raptors and three owl species. Where sample size allowed, trends were also calculated for biogeographic areas (Bird Conservation Regions) and in each of the last three decades.

Among the long-term trends for Canada, more species had positive (10) than negative (7) trends, but only five of these were statistically significant. A non-significant trend with a sufficiently large sample size indicates that there is no consistent change in the population; small sample sizes have data that are too variable to characterise a population trend.

According to the BBS, the Turkey Vulture is increasing in the overall analysis for Canada (Table 2) and in the Lower Great Lakes/St. Lawrence Plain. In the Boreal Hardwood Transition, the only other BCR for which a trend could be calculated, the Turkey Vulture population appeared stable; however, the sample size is small and this result should be treated with caution.

Trends for both Osprey and Bald Eagle were not statistically significant in any time period or geographic unit, although sample sizes were sufficiently large in Canada overall and several BCRs to suggest that the populations are stable.

Northern Harrier decreased significantly over the long-term in Canada, the Boreal Taiga Plains and the Prairie Potholes, and these declines were reflected in the 10-year trends. Populations showed no consistent sign of change in any of the other BCRs for the full period of the survey. Significantly decreasing 10-year trends occurred in the Boreal Taiga Plains (1981-1990) and, most recently, in the Lower Great Lakes/St. Lawrence Plain.

Sample sizes for Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk and Red-shouldered Hawk were sufficient to calculate only Canada-wide trends for the entire survey period. The results suggest that there were no consistent changes in populations of these species. However, sample sizes were small for the latter two species and should be interpreted with caution.

Broad-winged Hawk populations showed a significant increase in Canada over the long-term and in the Boreal Hardwood Transition region during the last ten years. The non-significant trends in the other BCRs and time periods suggest there was no consistent change in population.

Results for the Swainson's Hawk indicate a stable population in Canada over the long term. In contrast, during the last 10 years of the survey the populations declined significantly in Canada overall and in the Prairie Potholes.

Over the long-term, Red-tailed Hawks increased significantly in Canada, the Great Basin and the Prairie Potholes but declined in the Lower Great Lakes/St. Lawrence Plain. The significant decline seen in the 1991-2000 trend for the Lower Great Lakes/St. Lawrence Plain in contrast to the two earlier decades suggests that the long-term trend in this BCR is a result of changes in the last 10 years. Trends for the other decades show a mixture of non-significant positive and negative trends, most with sufficient sample size to indicate there was no consistent change in population.

The trends for Ferruginous Hawk appeared stable overall but showed a significant decline in population over the last 10 years in the Prairie Potholes.

American Kestrels appear stable in Canada overall, increased during the last two decades in the Boreal Taiga Plains but showed a long-term decline in the Boreal Softwood Shield.

Merlin populations appear to be doing well. They were stable in Canada over the long-term and showed significantly increas-

ing populations during the last decade both in Canada overall and the two BCRs where sample sizes were sufficient to calculate a trend.

The Great Horned Owl showed a negative long-term trend in Canada and the Boreal Taiga Plains but an increase in population in the Prairie Potholes.

Sample sizes for Barred Owl and Short-eared Owl were sufficient to calculate trends only for the entire survey period and only in Canada and one other BCR. These trends were not significant indicating that the BBS could detect no consistent change in populations.

The above results, with a few notable exceptions, are consistent with those reported in the more detailed analysis by Kirk and Hyslop (1998) using BBS and other data to the mid-1990s. That study reported stable populations in Northern Harriers across Canada but a decline in the Boreal Taiga Plains region; the current BBS results show significantly decreasing populations both in Canada and in several regions. The marginal decline of Red-tailed Hawk in the Great Lakes/St. Lawrence region noted by Kirk and Hyslop has continued, with the BBS results now showing a large, significant decline. They reported Ferruginous Hawk as stable or increasing, and, while BBS results concur over the long-term, the current results detect a significant decline in the Prairie Pothole region during the last decade. Finally, the significant long-term decline in Great Horned Owl for Canada detected by the BBS sharply contrasted with the stable population trend reported by Kirk and Hyslop (1998).

There are two possible inferences from these differences in results. One is that the additional years of BBS data (to 2000) clarified population trends not yet apparent during the earlier study. The other is that these species are not well-monitored by either data set. Although there are clearly deficiencies in the geographic coverage of raptors by the BBS, the considerable volume of data for this group of birds can still provide some useful insight into their population trends.

References

Kirk, D.A., and C. Hyslop. 1998. *Population status and recent trends in Canadian raptors: a review.* Biological Conservation 83: 91-118.

Raptors at risk in Canada

Mary Rothfels, CWS National Office, Gatineau, QC K1A 0H3; Mary.Rothfels@ec.gc.ca

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) updated its list of nationally at risk species (endangered, threatened or of special concern) in November 2002. Of the 58 bird species and subspecies designated, 14 (24.1%) are raptors — eight owls, three hawks and three falcons.

Four of the raptors are endangered (Northern Spotted Owl [*Strix occidentalis caurina*], Burrowing Owl [*Athene cunicularia*], eastern population Barn Owl [*Tyto alba*], and Western Screech-Owl [*Otus kennicotti macfarlanei*]), two are threatened (Queen Charlotte Goshawk [*Accipiter gentilis laingi*] and *anatum* Peregrine Falcon [*Falco peregrinus anatum*]), and eight are of special concern (Short-eared Owl [*Asio flammeus*], Flammulated Owl [*Otus flammeolus*], western population Barn Owl [*Tyto alba*], Western Screech-Owl [*O. k. kennicottii*], Ferruginous Hawk [*Buteo regalis*], Red-shouldered Hawk [*Buteo lineatus*], and *tundrius* and *pealei* races of the Peregrine Falcon).

An "Endangered" species is one that faces imminent extirpation or extinction, a "Threatened" species is likely to become endangered if limiting factors are not reversed, and a "Special Concern" (formerly "Vulnerable") species has characteristics that make it particularly sensitive to human activities or natural events.

Threats to these raptors follow a fairly consistent theme of habitat loss and degradation leading to lack of nest sites and prey. Forestry activities affect the northern Spotted Owl, Queen Charlotte Goshawk, Red-shouldered Hawk and Flammulated Owl. Expanding agriculture and housing development have led to declines in the Barn Owl, Ferruginous Hawk and Short-eared Owl, and pose an additional threat to the Flammulated Owl. Prey species of many raptors have declined due to pesticides and other chemicals in the environment, with these impacts especially well documented for the *anatum* Peregrine Falcon.

No single threat accounts for the continued decline of the endangered Burrowing

Owl, but lack of prey for nesting owls and their young is reducing productivity in the breeding grounds. More unique among raptors is the situation facing the Peale's Peregrine Falcon: loss of seabird prey on coastal islands as a result of predation by introduced or invasive mammals. Limited nest site availability for the Ferruginous Hawk and Barn Owl is a threat that is more easily addressed through provision of artificial nest platforms and boxes.

Nationally endangered and threatened species come under the purview of RENEW, the national recovery program. National recovery teams are in place for the northern Spotted Owl, Burrowing Owl, eastern Barn Owl and *anatum* Peregrine Falcon. The situation of the northern Spotted Owl, down to 100 pairs in Canada (1998 estimate) and declining, is relatively bleak. Although the distribution of the owl is better understood, the impact of forestry on old growth forest habitat continues, and the management plan that was developed for the species does not meet the requirements of a recovery plan.

Information on Canada's species at risk and their recovery, by species or by geographic area, is available by Internet at: http://www.speciesatrisk.gc.ca/species/index_e.cfm

The remaining three recovery teams have been very active, with new recovery strategies in development and good community support for recovery programs. Operation Burrowing Owl in Prairie Canada is one of our country's flagship stewardship programs, with a broad network of volunteers providing nest site protection and population abundance data, while the research members of the recovery team concentrate on identifying and mitigating other threats to this small owl. On a smaller scale, landowners in southwestern Ontario are participating in erecting and monitoring some 300 nest boxes for Barn Owls in the hope of boosting the number of breeding pairs of this peripheral species from 4–6 pairs to more than 20 pairs.

The hard-won recovery of the *anatum* peregrine to stable or increasing population levels is the feature raptor success story. Now that the goal and objectives of the 1987 recovery plan have been met and the subspecies has been down-listed from endangered to threatened, the recovery team is developing and implementing an updated recovery strategy that may lead to a "special concern" designation in 2003.

References

Anatum Peregrine Falcon National Recovery Team. 2001. Anatum *Peregrine Falcon Recovery Strategy & Action Plan*. First Draft, June 2001. Not for general distribution.

Burrowing Owl National Recovery Team. 2001. *Western Burrowing Owl Recovery Strategy*. Second Draft, November 2001. Not for general distribution.

Canadian Endangered Species Conservation Council. 2001. *RENEW 2000-2001 Annual Report No. 11*. Recovery of Nationally Endangered Wildlife. Http://www.speciesatrisk.gc.ca/species/es/renew/RENEW00_01/eng/toc_e.htm

COSEWIC. November 2002. *Canadian Species At Risk*. Committee on the Status of Endangered Wildlife in Canada. http://www.cosewic.gc.ca/eng/sct5/index_e.cfm

Erickson, G., R. Fyfe, R. Bromley, G.L. Holroyd, D. Mossop, B. Munro, R. Nero, C. Shank, and T. Wiens. 1988. *Anatum Peregrine Falcon Recovery Plan*. Ottawa: Environment Canada, Canadian Wildlife Service, 52 pp. Http://www.speciesatrisk.gc.ca/species/publications/plans/perfal_e.cfm

Hjertaas, D., S. Brechtel, K. De Smet, O. Dyer, E. Haug, G. Holroyd, P. James, and I. Schmutz.1995. *National Recovery Plan for the Burrowing Owl*. Report No. 13. Ottawa: Recovery of Nationally Endangered Wildlife Committee, 33 pp. Http://www.speciesatrisk.gc.ca/species/publications/plans/burowl_e.cfm

Schmutz, J.K., S. Brechtel, K. De Smet, D. Hjertaas, C. Houston, and G. Holroyd. 1994. *National Recovery Plan for the Ferruginous Hawk*. Report No. 11. Ottawa: Recovery of Nationally Endangered Wildlife Committee, 35 pp. Http://www.speciesatrisk.gc.ca/species/publications/plans/ferhaw_e.cfm

Urban Sharp-shinned Hawk productivity in Quebec

Joanna L. Coleman and David M. Bird, Avian Science and Conservation Centre, McGill University, Ste-Anne-de-Bellevue, Quebec H9X 3V9; joannalouisec@hotmail.com, bird@nrs.mcgill.ca

Beginning in the 1940s, Sharp-shinned Hawk (*Accipiter striatus*) populations declined sharply, likely due to hunting, egg collection (Bildstein and Meyer 2000), and, more importantly, the widespread use of DDT (Snyder *et al.* 1973). By the 1970s the species appeared to have completely rebounded (Bednarz *et al.* 1990), and it is not currently listed in any category of risk either provincially or federally. The Sharp-shinned Hawk is likely one of the most numerous, though uncommonly seen, raptors in the country (Kirk 1997). Trend data in Canadian populations,

however, are equivocal (Kirk *et al.* 1995; Viverette *et al.* 1996; Kirk 1997; Kirk and Hyslop 1998). There is no information about the size of specific breeding populations (probably because their nests are difficult to find; Kirk 1997), and counting Canadian birds is virtually impossible as they mix with birds from other regions on the wintering grounds (Kirk *et al.* 1995).

Still, population numbers and trends are inferred from various sources. Although the Breeding Bird Survey (BBS) is the most comprehensive method for monitoring North American landbird populations, its coverage is limited to roadside habitats, where secretive forest-dwellers like accipiters are unlikely to be observed (Kirk and Hyslop 1998). Christmas Bird Count (CBC) totals may also be inflated by participants who count birds at feeders, a particular concern for Sharp-shinned Hawks that often hunt around feeders. This bias increases at higher latitudes, where feeder watchers make up a greater proportion of participants and more wintering birds visit feeders. CBCs, then, are less reliable for estimating trends in Canadian Sharp-shinned Hawk populations than elsewhere (Dunn 1995).

Most of the available information about Sharp-shinned Hawk populations comes from migration count data. Sharp-shinned Hawks are rarely seen during the breeding season, but migrants aggregate along well-used flyways. Northeastern populations have two main migratory routes: the inland route along the easternmost ridge of the Appalachians is mainly used by adults, while juveniles tend to follow the Atlantic coast (Viverette *et al.* 1996). Lookouts along these routes have been used as counting sites since the early 1900s. These counts may be the most important source of data about many raptor populations, but their ability to discern trends has been questioned due to the bias introduced by variable observer effort between years and the influence of weather on migratory behaviour (Bednarz *et al.* 1990). However, when combined, the data from different watch sites appear to be valuable indicators of trends over long periods of time and large geographical areas (Bednarz *et al.* 1990; Titus and Fuller 1990).

Kirk and Hyslop (1998) reviewed the population trends and status of numerous Canadian raptors according to various data sources. Overall, Sharp-shinned Hawks increased from the mid-1960s to the mid-1990s, according to the BBS and the CBC, but declined from 1985–1994, according to the BBS. This parallels a 92% decline from 1979 to 1992 at Cape May Point, New Jersey, and a 23% decline for the same period at Hawk Mountain, Pennsylvania (Viverette *et al.* 1996). While counts at other eastern lookouts also declined, they did not at sites west of the Great Lakes (Kerlinger 1993). Since 1992, Sharp-shinned Hawk counts at Cape May Point have been on the rise. This may be a sign that a separate population in the Maritimes is rebounding from the effects of spruce budworm outbreaks and the associated pesticide spraying in the late 1970s. Sharpshins there were affected by declines in their songbird prey caused by the reduced availability of a broad spectrum of insect food, as well as by loss of nesting cover due to widespread defoliation. On the other hand, counts at Hawk Mountain have continued to decrease slightly (N. Bolgiano, unpubl. data), which may corroborate some evidence of recent declines in Canadian populations (Kirk and Hyslop 1998).

Some of this decline can be attributed to a shift in overwintering populations to the north of these lookouts of more than 7% per year from 1979 to 1989 (Viverette *et al.* 1996). Declines were reported along the coastal route four years before a similar trend was noticed at Hawk Mountain (Laura 1992) which may reflect a greater tendency for juveniles to change their migratory patterns (Viverette *et al.* 1996), but could also indicate decreased productivity. Bohall Wood *et al.* (1996) found higher levels of DDE and PCBs (known to reduce productivity) in migrants sampled at eastern lookouts than at sites west of the Great Lakes. The reduced availability of suitable breeding habitat as a result of urbanization, forestry and/or forest aging is also a possible contributing factor (Viverette *et al.* 1996).

© David A. Kirk

To assess the effect of urbanization on Sharp-shinned Hawk productivity, parameters of reproductive success were measured for 25 Sharp-shinned Hawk nests located between 1999 and 2001. The study area was located in southwestern Quebec, a region that has lost more than 75% of its forest cover since settlement. The area is dominated by the city of Montreal, which has less green space (only about 10% of which is wooded) per person than any other Canadian city (Government of Canada 1996).

Overall nesting success was determined by dividing the number of successful nests by the number of active nests. A nest was considered active if eggs were laid, a female in incubating posture was present, or one or both members of a pair exhibited defensive behaviours. Putative parents were aged as mature or immature, based upon plumage. Whenever possible, a pole-mounted mirror was used to measure clutch size and hatching success. The mean clutch size of 4.5 (Table 3) was within the normal range (4–5) for sharpshins breeding in temperate climates (Bildstein and Meyer 2000). Clutch size may be affected by habitat quality, and, at least in the closely related Sparrowhawk (*A. nisus*) in Europe, nests with more eggs fledge more young (Newton 1991).

Hatching success is a valuable measure of population health, and this population's mean rate is comparable to the highest values reported for North America. Brood size and the mean number of nestlings that reached a bandable age (i.e., at least 12 days old) are also within the ranges measured for other Sharp-shinned Hawk populations.

The relatively high percentage of immature breeders is noteworthy. Yearling males and females were almost equally likely to breed, and pairings between yearlings occurred fairly frequently and did not tend to result in decreased success. Other studies have found that productivity was lower for pairs containing yearlings than for pairings between adults (Jacobs and Semo 1997), and lowest for pairings between yearlings (Newton 1991). Higher proportions of yearling breeders are often observed when environmental conditions are especially conducive to breeding, i.e., abundant food supply and/or good habitat quality (Newton 1979). A longer-term study might be able to determine whether the Montreal population consistently contains more immature breeders than other populations, and the environmental conditions underlying this phenomenon.

Nesting success, however, was fairly low at 60.0% and demonstrated considerable disparity between years (1999: 100% [n=7]; 2000: 30.0% [n=10]; 2001: 62.5% [n=8]). It is difficult to infer the reasons for this variation in success. Although the nests in 2000–2001 were more disturbed in the course of this study than they were in 1999 when nests were only observed, careful analysis of the particular circumstances of each failure suggests that researcher disturbance was not the cause. Weather conditions were more likely implicated in the increase in nest failures, especially in 2000. Inclement weather can reduce both prey availability and the hunting efficiency of raptors, while increasing their energy requirements and nestling mortality. Wet weather has been linked to reduced productivity in Ospreys (*Pandion haliaetus*) (Odsjö and Sondell 1976), Black Eagles (*Ictinaetus malayensis*; Gargett 1977) and Sparrowhawks. In Montreal, the summer of 2000 arrived late and was characterized by

Table 3. Comparison of Sharp-shinned Hawk breeding parameters from Montreal to other North American locations.

Location	Clutch size	% Hatching success	No. of nestlings (bandable)	% Immatures female/male	Yearling pairs (%)	% Nesting success (range)	Reference
Montreal	4.5	85.1	3.8 (3.1)	30.0/26.3	16	60 (30-100)	
Wisconsin	4.3		-3.6	28/11	5		Jacobs, unpub data; Jacobs & Semo 1997
Scotland				15/18	6.3		Newton 1991
Oregon	4.6	70		0/0	--	91.7	Reynolds & Wight 1978
Missouri	4.5		3.5				Wiggers & Kritz 1994
New Brunswick		87		0/0	--	95	Meyer 1987
North America	3.9		2.7				Apfelbaum & Seelbach 1983

unseasonably cold temperatures and above average precipitation (A. Julien, pers. comm.). The disparity in nesting success between years of the study may be nothing more than an artefact, as evidenced by healthy clutch sizes and hatching success rates.

Overall, our results do not indicate a decline in the Sharp-shinned Hawk population in the Montreal area. A wide range of raptors including Red-shouldered Hawks (*Buteo lineatus*), Eastern Screech-Owls (*Otus asio*), Mississippi Kites (*Ictinia mississippiensis*) and Cooper's Hawks (*A. cooperii*) have been found to be equally or more productive in urban areas than in rural areas (Bloom and McCrary 1996; Gehlbach 1996; Parker 1996; Rosenfield *et al.* 1996, respectively). While a short-term productivity study may not predict long-term trends in this population, it provides baseline data and potential nest site locations to serve as the starting point for a longer-term investigation.

References

Aptelbaum, S.I. and P. Seelbach. 1983. *Nest tree, habitat selection and productivity of seven North American raptor species based on the Cornell University nest record card program*. J. Raptor Res. 17:97-113.

Bednarz, J.C., D. Klem Jr., L.J. Goodrich, and S.E. Senner. 1990. *Migration counts of raptors at Hawk Mountain, Pennsylvania, as indicators of population trends, 1934-1986*. Auk 107:96-109.

Bildstein, K.L. and K. Meyer. 2000. *Sharp-shinned Hawk* (Accipiter striatus), *in* "The Birds of North America, No. 482" (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia and the American Ornithologists' Union, Washington, DC.

Bloom, P.H. and M.D. McCrary. 1996. *The urban Buteo: Red-shouldered Hawks in southern California*. *In* "Raptors in Human Landscapes" (D.M. Bird, D.E. Varland, and J.J. Negro, eds.). Academic Press, San Diego, CA.

Bohall Wood, P., C. Viverette, L. Goodrich, M. Pokras, and C. Tibbott. 1996. *Environmental contaminant levels in Sharp-shinned Hawks from the eastern United States*. J. Raptor Res. 30:136-44.

Dunn, E.H. 1995. *Bias in Christmas Bird Counts for species that visit feeders*. Wilson Bull. 107:122-130.

Gargett, V. 1977. *A 13-year population study of the Black Eagles in the Matapos, Rhodesia*. Ostrich 48:17-27.

Gehlbach, F.R. 1996. *Eastern Screech Owls in suburbia: a model of raptor urbanization*. *In* "Raptors in Human Landscapes" (D.M. Bird, D.E. Varland, and J.J. Negro, eds.). Academic Press, San Diego, CA.

Government of Canada. 1996. *The State of Canada's Environment*. Minister of Public Works and Government Services, Gloucester, ON.

Jacobs, E.A. and L.S. Semo. 1997. *Reproductive performance and nesting phenology of adult and yearling Sharp-shinned Hawks* (Accipiter striatus) *in Wisconsin*. Annual meeting of the Raptor Research Foundation, Savannah, GA. [abstract].

Kerlinger, P. 1993. *Sharp-shinned Hawk populations in tree-tall*. Winging It 5(9):10-11.

Kirk, D.A. 1997. *Update COSEWIC Status report on Sharp-shinned Hawk*, Accipiter striatus. Unpubl. report for the Committee on the Status of Endangered Wildlife in Canada, Ottawa K1A 0H3.

Kirk, D.A., D. Hussell, and E. Dunn. 1995. *Raptor population status and trends in Canada*. Bird Trends 4:2-9. Canadian Wildlife Service, Ottawa.

Kirk, D.A. and C. Hyslop. 1998. *Population status and recent trends in Canadian raptors: a review*. Biol. Conserv. 83:91-118.

Laura, T. 1992. *Northern Appalachians Region Summary*. HMANA Hawk Migration Studies. 17:40-54.

Meyer, K.D. 1987. *Sexual size dimorphism and the behavioural ecology of breeding and wintering Sharp-shinned Hawks* (Accipiter striatus). Ph.D. dissertation, Univ. North Carolina, Chapel Hill, NC.

Newton, I. 1979. *Population ecology of raptors*. Buteo Books, Vermillion, SD.

Newton, I. 1991. *The Sparrowhawk*. T. & A.D. Poyser Ltd. Staffs, GB.

Odsjö, T. and J. Sondell. 1976. *Reproductive success in Ospreys* Pandion haliaetus *in southern and central Sweden 1971-1973*. Ornis. Scand. 7:71-84.

Parker, J.W. 1996. *Urban ecology of the Mississippi Kite*. *In* "Raptors in Human Landscapes" (D.M. Bird, D.E. Varland, and J.J. Negro, eds.). Academic Press, San Diego, CA.

Reynolds, R.T. and H.M. Wight. 1978. *Distribution, density, and productivity of accipiter hawks breeding in Oregon*. Wilson Bull. 90:182-196.

Rosenfield, R.N., J. Bielefeldt, J.L. Affeldt, and D.J. Beckmann. 1996. *Urban nesting biology of Cooper's Hawks in Wisconsin*. *In* "Raptors in Human Landscapes" (D.M. Bird, D.E. Varland, and J.J. Negro, eds.). Academic Press, San Diego, CA.

Snyder, N.F., H.A. Snyder, J.F. Lincer, and R.T. Reynolds. 1973. *Organochlorines, heavy metals, and the biology of North American accipiters*. BioScience 23:300-305.

Titus, K. and M.R. Fuller. 1990. *Recent trends in counts of migrant hawks from northeastern North America*. J. Wildl. Manage. 54:463-470.

Viverette, C.B., S. Struve, L. Goodrich, and K.L. Bildstein. 1996. *Decreases in migrating Sharp-shinned Hawks* (Accipiter striatus) *at traditional raptor-migration watch sites in eastern North America*. Auk 113:32-40.

Wiggers, E.P. and K.J. Kritz. 1994. *Productivity and nesting chronology of the Cooper's Hawk and Sharp-shinned Hawk in Missouri*. J. Raptor Res. 28:1-3.

Population trends of Red-shouldered Hawks in Ontario

✠ Debbie S. Badzinski, Bird Studies Canada, Port Rowan, ON N0E 1M0; dbadzinski@bsc-eoc.org

Although once the most common diurnal raptor in deciduous forests of eastern North America, the Red-shouldered Hawk (*Buteo lineatus*) has experienced a dramatic, continent-wide decline in the last century (Crocoll 1994). In Canada, the Red-shouldered Hawk is a rare to locally uncommon breeding bird in southern Ontario, southwestern Quebec, and southern New Brunswick (Austen *et al.* 1994). It is listed as a species of Special Concern in Canada and as Vulnerable in Ontario. The latest population estimate for Canada is 2000–5000 pairs (Kirk *et al.* 1995).

The North American breeding range of the Red-shouldered Hawk extends south from Michigan, Ontario, Quebec, and New Brunswick to the Gulf of Mexico region of the United States and central Mexico; Ontario constitutes approximately 5% of the total North American breeding range (Austen *et al.* 1994). Ninety percent of breeding records for the Red-shouldered Hawk in Ontario are from the Lower Great Lakes/St. Lawrence Plain region, with a few additional breeding locations in the Carolinian and Southern Boreal forests. It is a rare breeder in northern Ontario, although it may have expanded its range northward in recent years (Bird Studies Canada, unpub. data).

Red-shouldered Hawks occur in a broad array of North American forest types, but they prefer large tracts of mature to old growth mixed forests, especially bottomland hardwood riparian areas and flooded deciduous swamps. This species requires closed canopy forests for successful reproduction and is sensitive to changes in forest structure following timber harvesting (Crocoll 1994). Furthermore, reduced canopy closure resulting from logging practices tends to benefit Red-tailed Hawks (*Buteo jamaicensis*), which may then displace or out-compete Red-shouldered Hawks in forest fragments (Bryant 1986).

Because of their dependence on large, mature forests, and the potential for forest management practices to negatively affect the Red-shouldered Hawk, the Ontario Ministry of Natural Resources' Wildlife Assessment Program (OMNR-WAP) chose the Red-shouldered Hawk as a key indicator species of forest health. In response, Bird Studies Canada in partnership with OMNR-WAP initiated the Red-shouldered Hawk and Spring Woodpecker Survey in 1991. The primary objectives of the survey are to provide statistically reliable population trend data for Red-shouldered Hawks (as well as Pileated Woodpeckers and Yellow-bellied Sapsuckers) and to determine whether forest management practices are having a negative impact on these species (Badzinski 2001).

The Red-shouldered Hawk and Spring Woodpecker Survey is a roadside survey that uses playback calls to elicit responses from Red-shouldered Hawks. Through passive listening or visual observations the presence of other raptor and woodpecker species are documented. The study area is restricted to deciduous or mixed forest habitat in central Ontario, the core breeding range of the Red-shouldered Hawk. Power analyses have shown that with the current number of routes (N=93 in 2001), the survey is able to detect any major changes in population size of the Red-shouldered Hawk due to forest management practices or other disturbances (Whittam and Francis 1999).

To calculate annual population indices for Red-shouldered Hawks from 1991-2001, Poisson regression models were used. This approach was also used to estimate long-term trends for the Red-shouldered Hawk, assuming that the population has been changing by the same proportion in every year (see Badzinski 2001 for more detail).

Population trends of Red-shouldered Hawks based on data collected from the Red-shouldered Hawk and Spring Woodpecker Survey from 1991-2001 showed that despite annual fluctuations, the population has shown no significant change and thus appears to be stable (slope of +1.3% per year, P = 0.15; Fig. 2). The significant

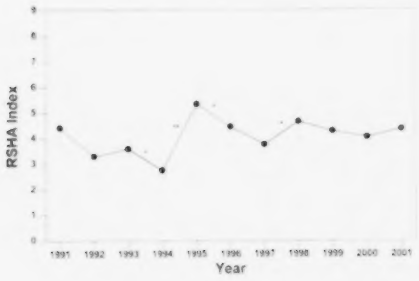


Figure 2. Estimated annual indices for Red-shouldered Hawk counts, 1991-2001.
95% confidence limits reflect differences to 2001. Significant post-hoc year-to-year differences are marked: + =P<0.10, * =P<0.05, ** = P<0.01.

increases in detection of Red-shouldered Hawks in 1995 and 1998 may be due to increases in tape quality in those years (Francis 1999). Tape quality has been standardized since 1998, and there has been little change in population indices since that time. The highest density of Red-shouldered Hawks occurs in eastern Ontario, near Kingston (Fig. 3).

Long-term data (1967–2000) collected from the Breeding Bird Survey (BBS) in Canada also show little change in the Red-shouldered Hawk population (+0.30%, N=21 routes; Sauer *et al.* 2001); BBS data throughout North America for the same time period indicate a significant population increase (+2.6% per year, N=809; Sauer *et al.* 2001). However, it is important to remember that BBS may not be an effective means of monitoring Red-shouldered Hawks because the birds are most conspicuous, and thus most easily detected, during their pre-incubation period (late April to early May in Ontario), which is much earlier than the June BBS season.

Data from the Red-shouldered Hawk and Spring Woodpecker Survey and other bird surveys suggest that the Red-shouldered Hawk population in Ontario is stable or increasing slightly. However, because of its specific habitat requirements, it is unlikely this species will ever recover to historic abundance. The continued alteration of its preferred habitat through forestry, and the loss of forests in general due to urbanization remain threats. Continued monitoring of Red-shouldered Hawks and other forest dwelling raptors is necessary to ensure that populations remain stable.

Acknowledgements

Thanks to all the dedicated Red-shouldered Hawk surveyors from 1991-2001 who collected this valuable data.

References

Austen, M.J.W., M.D. Cadman, and R.D. James. 1994. *Ontario Birds at Risk: status and conservation needs.* Federation of Ontario Naturalists, Don Mills, Ontario and Long Point Bird Observatory, Port Rowan, Ontario.

Badzinski, D.S. 2001. *The Red-shouldered Hawk and Spring Woodpecker Survey – 2001 Final Report.* Unpublished report from Bird Studies Canada to the Wildlife Assessment Program, Ontario Ministry of Natural Resources.

Bryant, A.A. 1986. *Influence of selective logging on red-shouldered hawks, Buteo lineatus, in Waterloo region, Ontario, 1953-1978.* Can. Field Nat. 100:520-525.

Crocoll, S.T. 1994. *Red-shouldered Hawk* (Buteo lineatus). *In* "The Birds of North America, No. 107" (A. Poole and F. Gill, eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Francis, C.M. 1999. *Red-shouldered Hawk and Spring Woodpecker Survey – 1998 Final report.* Unpublished report by Bird Studies Canada to the Wildlife Assessment Program, Ontario Ministry of Natural Resources.

Kirk, D.A., D. Hussell, and E. Dunn. 1995. *Raptor population trends and status in Canada.* Bird Trends 4:2-9.

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. *The North American Breeding Bird Survey, Results and Analysis 1966 – 2000.* Version 2001.2. USGS Patuxent Wildlife Research Center, Laurel, MD. http://www.mbr-pwrc.usgs.gov/bbs/bbs.html

Whittam, B. and C.M. Francis. 1999. *Red-shouldered Hawk and Spring Woodpecker Survey – 1999 Final Report.* Unpublished report by Bird Studies Canada to the Wildlife Assessment Program, Ontario Ministry of Natural Resources.

Figure 3. Distribution of Red-shouldered Hawks (mean number of hawks per route), 1991-2001.

The recovery of Bald Eagles in Southern Ontario, 1980-2001

✠ Debbie S. Badzinski, Bird Studies Canada, Port Rowan, ON N0E 1M0; dbadzinski@bsc-eoc.org

Kimberly Szuba © OMNR

Throughout their range, Bald Eagles (*Haliaeetus leucocephalus*) have undergone dramatic fluctuations over the past two centuries. In Canada, Bald Eagles were once common throughout the Maritime Provinces, the Pacific coast, and around large inland water bodies in Saskatchewan, Manitoba, and Ontario. They were once distributed throughout Ontario from the lower Great Lakes northward to the tree line (Austen *et al.* 1994), but today are common only in northern Ontario. In 1998, there were 1193 documented active nests in northwestern Ontario and 185 in northeastern Ontario, a considerable increase over the 719 and 85 nesting records respectively in 1990 (Grier *et al.* 1998). In southern Ontario, Bald Eagles have recovered from near extirpation in the early 1960s to establish a small, slowly increasing population (Badzinski 2001).

Prior to settlement in the early 18th century, Bald Eagles were abundant along the northern shores of Lake Erie and Lake Ontario (Brownell and Oldham 1980). An estimated 200 pairs nested from the Ottawa River to the lower Great Lakes and nesting densities were as high as one nest per mile of shoreline along Lake Erie (Weekes 1974). Loss of nesting and foraging habitat, through the clearing of land for agriculture, along with direct human persecution, led to a decline in the Bald Eagle population in the southern Great Lakes (Austen *et al.* 1994).

The introduction of protective legislation, including the Ontario Ministry of Natural Resources' Game and Fish Act in 1890, and the American Bald Eagle Act in 1940, helped the southern Ontario eagle population rebound to approximately 100 pairs by 1950 (Weekes 1974). However, this recovery was short-lived, due to the introduction of synthetic chlorinated pesticides such as DDT and PCBs into the Great Lakes aquatic food chain. Bioaccumulation of DDT, and its breakdown product DDE, in the bodies of adult Bald Eagles led to widespread reproductive failure through eggshell thinning and embryo death (Donaldson *et al.* 1999).

Although Canada and the United States severely restricted the use of DDT and tightened regulations for industrial chemical disposal in the early 1970s (Neilson and Pollock 2001), the effects lingered on for many more years (Brownell and Oldham 1980). In 1980, the Great Lakes Bald Eagle population experienced complete reproductive failure: there were only three active nests along the north shore of Lake Erie in that year, and no young were produced (McKeane and Weseloh 1993). Bald Eagles were listed as nationally Endangered from 1978–1984, after which COSEWIC determined they were 'Not At Risk' due to the large, healthy populations of Bald Eagles along the west coast and in the boreal region of Canada (Neilson and Pollock 2001). In Ontario, the Bald Eagle retains the provincial Endangered species status it received in 1973.

The Southern Ontario Bald Eagle Monitoring Project, initiated in 1983, is a cooperative venture of the Ontario Ministry of Natural Resources, Canadian Wildlife Service, Bird Studies Canada, community organizations, landowners, and volunteer nest monitors. Every year, landowners and volunteer nest monitors collect valuable data on Bald Eagle nesting chronology, activity and productivity (mean number of chicks produced per nest), which allows biologists to monitor the status of the population.

In addition, from 1983–1999 every eaglet within the study area was weighed, measured, and banded; blood and feather samples were taken from eaglets between 1990-1999 to monitor levels of contaminants and heavy metals. Data collected from these field studies showed that by the mid-1990s, levels of contaminants had declined dramatically (Donaldson *et al.* 1999). Coincident with the decline in contaminants, the number of active nests and productivity increased, and the general health of the Great Lakes Bald Eagle population improved (Figs. 4 and 5).

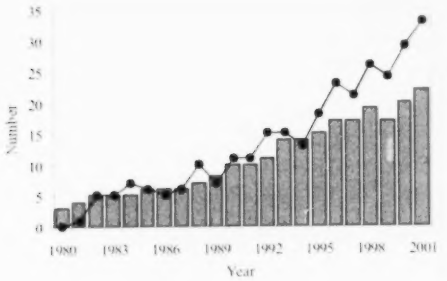


Figure 4. Number of active Bald Eagle nests in southern Ontario (bars), and the total number of eaglets produced (dots) from 1980-2001.

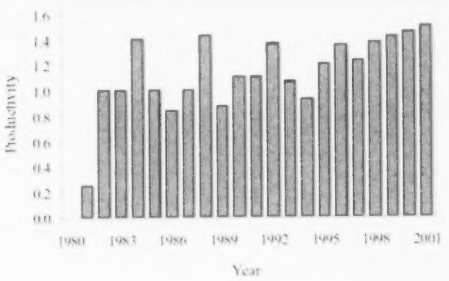


Figure 5. Productivity (mean number of chicks fledged per active nest) of Bald Eagles in southern Ontario between 1980 and 2001.

In 2001, 33 eaglets were produced from 22 active nests, a significant improvement since 1980 (Fig. 4, Table 4). There was high annual variation in nesting productivity from 1980–1995, but overall, productivity increased during that period (Fig. 5). During the last five years, nesting productivity appears to have stabilized at 1.4–1.5 fledglings per active nest, which is likely sufficient to maintain a stable population. Currently, most of the Bald Eagle nests in southern Ontario (59%) are located along the north shore of Lake Erie, but the species has not yet returned to the north shore of Lake Ontario, probably due to a lack of suitable habitat away from human development.

Future prospects for the recovery of Bald Eagles in southern Ontario are positive, but there are continuing concerns about the long-term viability of the population. Bald Eagles in southern Ontario appear to have shortened life spans of 8–11 years, compared with up to 30 years in other populations (Whittam 2000). A possible explanation for the shortened life span of Great Lakes eagles could be heavy metal poisoning. In the last few years, several Bald Eagles found dead in Ontario have had elevated levels of both mercury and lead in their bodies. Long-term exposure to such contaminants can limit reproductive capabilities, alter behavior and impair foraging abilities, increase susceptibility to disease, and even result in death. Determining whether long-term heavy metal exposure is responsible for decreased longevity is one of the main issues the Southern Ontario Bald Eagle Monitoring Project will address in the future.

References

Austen, M.J.W., M.D. Cadman, and R.D. James. 1994. *Ontario Birds at Risk: status and conservation needs.* Federation of Ontario Naturalists and Long Point Bird Observatory, Ontario. 165 pp.

Badzinski, D. 2001. *Southern Ontario Bald Eagle Monitoring Project: 2001 Final Report.* Unpublished report by Bird Studies Canada to the Ontario Ministry of Natural Resources and the Canadian Wildlife Service. 16 pages.

Brownell, V.R., and M.J. Oldham. 1980. *Status report on the Bald Eagle in Canada.* Haliaeetus leucocephalus. Prepared by the Ontario Ministry of Natural Resources for the Committee on the Status of Endangered Wildlife in Canada.

Donaldson, G.M., J.L. Shutt and P. Hunter. 1999. *Organochlorine contamination in bald eagle eggs and nestlings from the Canadian Great Lakes.* Arch. Environ. Contam. Toxicol. 36: 70-80.

Grier, J.W., T. Armstrong, P. Hunter, S. Lockhart and B. Ranta. 2001. *Draft report on the status of Bald Eagles in Ontario.* MS Report, Ontario Ministry of Natural Resources, Thunder Bay.

McKeane, L. and D.V. Weseloh. 1993. *Bringing the Bald Eagle back to Lake Erie.* Environment Canada. State of the Environment Fact Sheet 93-3:1-12.

Neilson, A.L. and I.S. Pollock. 2001. *Bald Eagle populations in the Great Lakes region: Back from the brink.* Environment Canada, Great Lakes Fact Sheet.

Weekes, F. 1974. *A survey of bald eagle nesting attempts in southern Ontario, 1969-1973.* Canadian Field Naturalist 88:415-41.

Whittam, B. 2000. *Southern Ontario Bald Eagle Monitoring Project, 2000 Report.* Bird Studies Canada, Port Rowan, Ontario.

For more information on the Southern Ontario Bald Eagle Monitoring Program, please contact:
Debbie Badzinski
Southern Ontario Bald Eagle Monitoring Program Coordinator
Bird Studies Canada
P.O. Box 160
Port Rowan, ON N0E 1M0
1-888-448-2473
dbadzinski@bsc-eoc.org

Table 4. Summary of Bald Eagle nesting activities in Southern Ontario in 2001.

Reproductive Parameter	Value
Number of occupied territories:	27
Lake Erie	16
Lake Huron	4
Detroit River	2
Lake St. Clair	1
St. Lawrence River	1
Inland – eastern Ontario	3
Number of active nests	22
Number of successful nests	20 (91%)
Nests that fledged 1 young	7
Nests that fledged 2 young	13
Nests that fledged 3 young	0
Total number of young produced	33
Young/occupied territory	1.2
Young/successful nest	1.6
Productivity (young/active nest)	1.5

The Bald Eagle population in New Brunswick

✠ Rudy Stocek, Maritime Forest Ranger School, Fredericton, NB E3C 2G6; rstocek@mfrs.nb.ca

New Brunswick has an expanding Bald Eagle population made up of both breeding and wintering birds. The northern Bald Eagle (*Haliaeetus leucocephalus alascanus*) is the resident species, and the much less frequent southern variety (*H. l. leucocephalus*) is part of the summering population. Eagles spending the summer in the province include breeding adults, non-breeding adults, immatures (subadults), and later in the season, juvenile birds. Most summering birds are seen along the Bay of Fundy and the larger rivers and lakes of the southwestern counties. Fewer eagles are seen to the east or to the north, including Northumberland Strait (Gulf of St. Lawrence) and the Bay of Chaleur. The wintering population includes all age classes.

The Bald Eagle was never a common bird in the province. However, during the 1930s and '40s, 20 to 30 eagles were reportedly seen daily during the summer on the waterfowl breeding grounds in central New Brunswick (around Grand Lake in the Saint John River drainage). Banding returns suggested that most of these birds were juveniles of the southern subspecies, wandering north after earlier fledging further south (e.g., from Florida). Very few nests were reported then or before in the province (Squires 1952), and, as eagle numbers decreased, few nesting sites continued to be active (Squires 1976). The decrease in the nesting success of the southern Bald Eagle likely contributed to the summer decline in New Brunswick (Stocek 1979).

The Bald Eagle was put on the first provincial endangered species list in 1976 because of its low numbers and sparse breeding areas. Aerial surveys were conducted from 1974 to 1998 to assess reproduction and status. Annual surveys in April from low-flying aircraft assessed the occupancy of eagle breeding areas, followed by one or two mid-summer aerial visits to determine success and productivity. Additional ground surveys (often involving volunteers) were conducted from 1999 to 2001.

One hundred and thirty-eight breeding areas, with 163 nest sites, were recorded in New Brunswick between 1974 and 2001. The majority of nesting eagles are attracted to the southwestern part of the province (Fig. 6).

Figure 6. The province of New Brunswick showing the number of Bald Eagle breeding areas by county, 1974–2001. The two Charlotte County values (25 and 23) represent mainland and marine locations. The largest marine island in the Bay of Fundy is Grand Manan.

The number of occupied nests (Fig. 7) increased steadily from the 15 nests seen in the mid 1970s to 68 in 1998. A change in nest occupancy is particularly evident during the 1990s, when the number of breeding pairs was increasing more rapidly. Nest success for most years was well above 50%, averaging 67% annually for the 25-year period (Fig. 8) with no apparent trend. Ground surveys from 1999 to 2002 detected a success rate from 74–83% for 177 nests. Sprunt *et al.* (1973) estimated that, to maintain a stable population, at least 50% of the breeding pairs should rear a mean of 0.7 young annually. Marine, estuarine, riverine and lacustrine breeding areas are used for nesting in the province, and all achieved respectable productivity (Table 5).

The number of young per occupied nest (Fig. 9) occasionally rose above the 1.0 mark, averaging 0.94 for the 25 years, compared to 1.09–1.25 from ground surveys. After an increase in the young reared in the 1970s, there appeared to be little trend in the data. Young per successful nest varied between 1.3 and 1.6 during the survey period. Table 6 summarizes these population parameters in 5-year intervals over the 25-year period.

Bald Eagles wintering in New Brunswick were infrequent in the past with only anecdotal records. In the early 1980s, January counts by volunteer observers using aircraft and other means tallied less than 25 birds per year in the southwest marine area of the

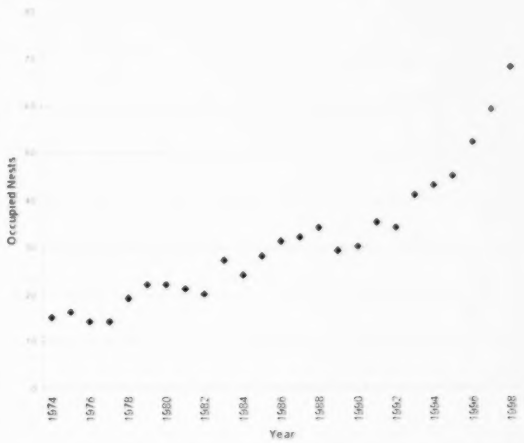


Figure 7. The number of occupied Bald Eagle nests in New Brunswick, 1974–1998.

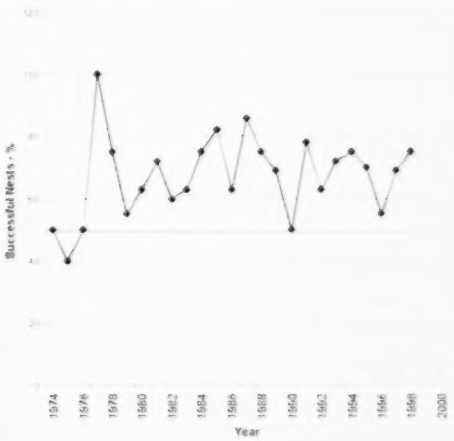


Figure 8. The percent of successful Bald Eagle nests in New Brunswick, 1974–1998. The fifty percent success rate is designated.

Table 5. Reproductive success of New Brunswick Bald Eagles by breeding habitat, 1990–1996.

Habitat	Occupied Nests	% Success	Young/ Occupied Nest	Young/ Successful Nest
Marine	53	65	0.96	1.47
Estuarine	51	76	1.04	1.37
Riverine	73	67	0.96	1.47
Lacustrine	98	61	0.9	1.47

Table 6. Reproductive success of Bald Eagles in New Brunswick by 5 year intervals,1974–1998.

Interval	Mean Occupied Nests	Mean Success Rate %	Mean Young/ Occupied Nest
1974 – 1978	16	63	0.75
1979 – 1983	22	63	0.89
1984 – 1988	30	76	1.12
1989 – 1993	34	66	0.95
1994 – 1998	53	69	1

province (including Grand Manan Island) and the lower Saint John river valley. Much of the winter activity occurs at the inshore coastal areas of the Bay of Fundy west of Saint John. The number of wintering eagles seen along the large river systems is now increasing as rivers remain free of ice for longer periods. The availability of road-killed and winter-killed deer is also likely contributing to the growing winter numbers.

An increase in the relative numbers of wintering eagles is also shown by Christmas Bird Count (CBC) results from 1978 to 1998 (Fig. 10). This data was compiled from 3 coastal sites (Eastport-Campobello, St. Andrews, Blacks Harbour) in southwestern New Brunswick where coastal islands are used as winter roosts. Fifty to 100 birds have been counted on some of these islands (Ralph Eldridge, personal communication). This increase is probably associated with the concurrent large increase in salmon aquaculture sites in the same area. Until the practice was prohibited in 1998, aquaculture operators often put out their culled salmon carcasses as food for eagles. Landfills where the salmon are often composted now attract 30–50 birds a day. Over 100 birds were counted along the southwest coast and islands in January 1992, 1994 and 1996. Observations from both volunteers and biologists suggest that between 200–300 wintering eagles currently use this area. Four major feeding stations in nearby Maine showed an increase in winter Bald Eagle numbers from 66 in 1981–1982 to 274 in 1984-1985. Banding results showed that some of the birds were from New Brunswick (McCollough 1986).

The dynamics of the eagle population in New Brunswick are likely influenced by a variety of human activities. Loss of breeding habitat (particularly due to forest harvesting and past road building), human disturbance, and shooting all reduced the number of breeding areas. Even with Endangered Species legislation eagle shooting continues today, although it seems to be considerably reduced. Immature eagles are prone to the effects of trapping, electrocution, collision and emaciation. Diseases and parasites have been noted in some eagle necropsies. Although forest spraying occurred in New Brunswick from 1952 to 1986, including the use of DDT/DDE until 1968, there is no evidence that eagles were affected; the few eagle breeding areas active at the time of spraying were not situated in the spray zones. However, recent human activities appear to be benefiting this species, as both the breeding and wintering populations of New Brunswick Bald Eagles have shown considerable growth in the last decade. This impressive bird can now be admired more frequently than in New Brunswick's past.

Acknowledgements

The Canadian Wildlife Service funded this work in 1974 and 1975 which was supported in subsequent years by the New Brunswick Department of Natural Resources & Energy. Thanks to the pilots who perilously flew at tree top height during this 25-year eagle survey, especially, Kevin Dorcas, as well as Ralph Eldridge and others who helped gather data. Eugene Mattinson, Girvan Harrison, and Heather Flinn made valuable contributions to this article.

References

McCollough, M.A. 1986. *The post-fledging ecology and population dynamics of bald eagles in Maine*. Ph.D. Thesis, University of Maine Orono. 104 pages.

Sprunt IV, A., W.B. Robertson Jr., S. Postupalsky, R.J. Hansel, C.E. Knoder, and F.J. Ligas. 1973. *Comparative productivity of six Bald Eagle populations*. Trans. N. Am. Wildl. Nat. Resour. Conf. 38:96-106.

Squires, W.A. 1952. *The Birds of New Brunswick*. The New Brunswick Museum, Saint John. 164 pages.

Squires, W.A. 1976. *The Birds of New Brunswick, Second edition*. The New Brunswick Museum, Saint John. 221 pages.

Stocek, R.F. 1979. *Decline of summering bald eagles in central New Brunswick*. Canadian Field-Naturalist 93(4): 443-445.

Figure 9. Productivity of the New Brunswick Bald Eagle breeding population, 1974– 1998 (shown as the number of young fledged per occupied nest).

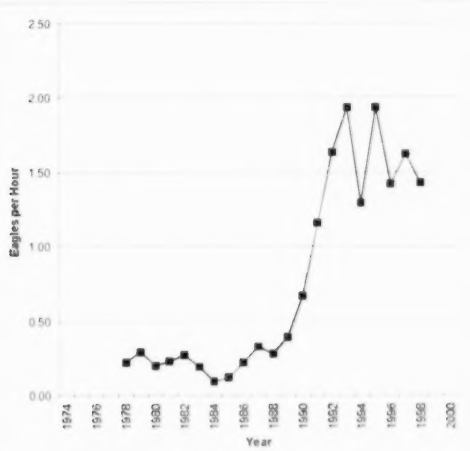


Figure 10. Christmas Bird Count numbers of Bald Eagles from 3 coastal stations in New Brunswick, 1978– 1998 (shown as eagles seen per hour).

Lessons we can learn from the natural variation in Northern Goshawk population trends

Frank Doyle, Wildlife Dynamics, Box 129, Telkwa, B.C. V0J 2X0; doyle@bulkley.net

The Northern Goshawk (*Accipiter gentilis*) is probably one of the most closely studied birds in North America due to its association with mature forests, and the possible impact of timber harvesting on its abundance. There is relatively little comparable wide-ranging geographic information available for other species, and the factors driving their population trends are largely unknown or inferred from local studies. Long-term population studies of the Northern Goshawk in the Yukon, British Columbia and Sweden reveal large annual variation in the size of breeding populations, but little annual variation in the number of young fledging per breeding pair. This article discusses some explanations for these apparently contradictory results based on the findings of three Canadian studies, and highlights the value of long-term studies in an increasingly managed forest landscape.

Although the three Canadian studies were all conducted in the northern boreal forest, local conditions greatly influence breeding parameters. In BC, studies were located in

the central north and northwest, in very different biogeoclimatic zones (Doyle and Mahon 2000, Mahon and Doyle 2000). Neither ecosystem showed a predictable annual variation in the availability of squirrels or passerines, prey upon which the goshawk depends in these environments. In contrast, the ecology of the goshawk in the Yukon is dominated by the annual cycles of its main prey, the snowshoe hare, and the associated changes in abundance of both ptarmigan and grouse (Doyle and Smith 1994, Boutin *et al.* 1995, Krebs *et al.* 2001). Extrapolating any of these data sets over the boreal forest as a whole would likely result in erroneous conclusions about the population status of the Northern Goshawk.

At a finer scale, the annual density of breeding pairs in the landscape (in suitable habitat) ranged from 0 –1 per 4 km in the Yukon study, peaking simultaneously with hare numbers. Within BC, the number of breeding pairs ranged from 0 –1 per 5 km, a difference possibly attributable to a failed cone crop, and the resulting reduction in the number of available squirrels. This in turn may be expected to have reduced the number of goshawks able to breed (Doyle 2000). However, like many species, goshawks are effectively surveyed only when they are actually breeding; with reduced breeding effort, birds may be present in the landscape but remain undetected. Conclusions about the abundance of goshawks or their critical habitat relationships derived from short-term monitoring should, therefore, be treated with caution.

Surveys of breeding raptors, including the Northern Goshawk, are often supplemented by migration counts. However, the Yukon study raises questions about the correlation between local breeding success and migration numbers. In the years following crashes in the hare population, a dramatic reduction in the number of goshawks was observed in the study area. This was accompanied by a dramatic increase in goshawks observed at migration stations both north and south of the Canadian border (Squires and Reynolds 1997, Kirk *et al.* 1995). This fostered the assumption that, in time of poor food availability, goshawks fly south (Muller *et al.* 1977). However, systematic surveys for goshawks and other raptors in the Yukon study area located eight goshawk carcasses in contrast to the years prior to the hare crash when no dead birds were found. Of the eight dead birds, 5 were emaciated and 2 were killed and eaten by Great Horned Owls (O'Donoghue *et al.* 1995). Noting this large number of dead birds in such a small area (100 km^2) strongly suggests that a large percentage of goshawks do not fly south to avoid food shortages. Furthermore, radioed goshawks stayed within the study area before the hare crash, but not after. Following the hare crash, radioed goshawks were just as likely to disappear to the north out of the study area as to the south along an established migration corridor (Doyle and Smith 1994). It is possible, then, that birds are moving in all directions in search of prey, while the perceived southward tendency is an artifact of the location of most migration monitoring stations on the southern edge of the boreal forest.

Reproductive success (the number of fledglings per pair) can also be a problematic measure of general population health or even population trends. The studies in both the Yukon and BC showed that goshawks that initiated breeding were typically successful in fledging young, and that the number of young is relatively consistent both annually and between study areas. The number of pairs breeding, however, can fluctuate dramatically, ranging from 0–1 during the full period of a hare cycle.

Taken together these individual goshawk studies and others conducted in North America and Europe (Squires and Reynolds 1997) show the complexity of factors that drive the population on a local scale. They also highlight the potential limitations of population trends derived from data from the few migration stations. Finally, they show how long-term data, from a variety of areas, is necessary to understand the underlying population status of the Northern Goshawk.

References

Boutin, S., C.J. Krebs, R. Boonstra, M.R.T. Dale, S.J. Hannon, K. Martin, A.R.E. Sinclair, J.N.M. Smith, R. Turkington, M. Blower, A. Byrom, F.I. Doyle, C. Doyle, D.S. Hik, L. Hofer, A. Hubbs, T. Karels, D.L. Murray, V.O. Nams, M. O'Donoghue, C. Rohner, and S. Schweiger. 1995. *Population changes of the vertebrate community during a snowshoe hare cycle in Canada's boreal forest*. Oikos 74:69-80.

Doyle, F.I. 2000. *Timing of reproduction in red-tailed hawks, northern goshawks and great horned owls in the Kluane Boreal Forest, southwestern Yukon*. M.Sc. Thesis. Dept of Zoology, UBC.

Doyle, F.I. and J.N.M. Smith. 1994. *Population response of Northern Goshawk to the 10-year cycle in numbers of snowshoe hares*. Studies in Avian Biology 16:122-132.

Doyle, F.I. and T. Mahon. 2000. *Inventory of the northern goshawk (Accipiter gentilis) in the Kispiox Forest District*. Ministry of Environment, Lands and Parks. Smithers, B.C.

Kirk, D.A, D. Hussell and E. Dunn. 1995. *Raptor population status and trends in Canada*. Bird Trends 4:2-9. Canadian Wildlife Service, Ottawa.

Krebs, C.J., S. Boutin and R. Boonstra. 2001. *Ecosystem Dynamics of the Boreal Forest: The Kluane Project*. Oxford University Press, New York.

Mahon, T. and F.I. Doyle. 2000. *Inventory of the northern goshawk (Accipiter gentilis) in the Lakes Forest District*. Ministry of the Environment, Lands and Parks. Smithers, B.C.

Muller, H.C., D.D. Berger, and G. Allez. 1977. *The periodic invasion of goshawks*. Auk 94:652 – 663.

O'Donoghue, M., E. Hofer and F.I. Doyle 1995. *Predator versus Predator*. Natural History 104(3):6-9.

Squires, J.R. and R.T. Reynolds. 1997. *Northern Goshawk (Accipiter gentilis)*. *In* "The Birds of North America, No. 298" (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, DC.

Queen Charlotte Goshawk: status, distribution, and population trends

Erica McClaren, Ministry of Water, Land and Air Protection, Nanaimo, BC V9T 6J9; Erica.McClaren@gems5.gov.bc.ca

The Queen Charlotte Goshawk (*Accipiter gentilis laingi*) is on the provincial *Red List* in British Columbia and is designated as Threatened in Canada (Cooper and Chytyk 2000). This subspecies is believed to have a restricted range along the Pacific Coast from Vancouver Island north to the Alexander Archipelago and Lynn Canal in southeast Alaska, and in coastal mainland Alaska (Webster 1988, Titus *et al.* 1994, Iverson *et al.* 1996, Ethier 1999). British Columbia contains the majority of the world population of Queen Charlotte Goshawk, where it occurs on Vancouver Island, the Queen Charlotte Islands and smaller coastal islands between Vancouver Island and mainland British Columbia. The distribution of Queen Charlotte Goshawks throughout the coastal mainland is unknown, but radio-tagged individuals from Vancouver Island have relocated to breed on adjacent coastal islands (McClaren 1997, 1999), and two birds have moved from Vancouver Island to the adjacent coastal mainland during the winter (McClaren 2000, 2001a). They likely also inhabit forests on the west side of the Coast Mountains throughout coastal mainland BC.

In winter, it appears that Queen Charlotte Goshawks undertake local movements (10 – 100 km) away from their nest areas but seldom migrate (Iverson *et al.* 1996, McClaren 1998, 1999, 2000, 2001a). Males remain closer to nest areas than females, and both sexes establish winter home ranges that may or may not include part of their breeding home ranges (Iverson *et al.* 1996, Levesque 2002). Whether Queen Charlotte Goshawks partake in the cyclic massive invasions southward reported for Northern Goshawks (Mueller and Berger 1967, Hofslund 1973, Mueller *et al.* 1977) is unknown.

Population trends for Queen Charlotte Goshawks are unclear in Alaska and British Columbia (Iverson *et al.* 1996, Cooper and Stevens 2000). While studies on Vancouver Island and in southeast Alaska are approaching the ten year mark, much longer-term demographic data are needed to understand the dynamics of this secretive bird that breeds less than annually and at relatively low densities. To date, studies have primarily focussed on describing goshawk habitat associations rather than on demography (McClaren *et al.* 2002).

Queen Charlotte Goshawks breed in mature and old forests throughout their range (Titus *et al.* 1994, Chytyk *et al.* 1997, McClaren 1997, 1998, 1999, 2000, 2001a). Because these forests are economically valuable to forest companies, habitat loss (as older forests are replaced by early seral stages following timber harvest) will likely affect goshawk reproduction and survival over time (Iverson *et al.* 1996, DeStefano 1998, Cooper and Stevens 2000). Currently though, this relationship

remains unclear (Kennedy 1997, McClaren *et al.* 2002). The associated risks include:

1) a reduced number of suitable nest areas;
2) decreased prey abundance and availability;
3) increased competition and predation from edge-adapted species;
4) reduced juvenile dispersal and gene flow;
5) increased human access and disturbance; and
6) altered microclimate conditions within interior forests.

Kandyd Scuba © OMNR

The latter may expose adults to inclement weather and influence their thermoregulatory capabilities, reducing their survival directly or their ability to successfully incubate eggs and brood young. For example, North *et al.* (2000) demonstrated that reproduction in California Spotted Owls (*Strix occidentalis occidentalis*) was higher when nest-site canopy cover was greater because canopy influenced nest-site microclimate.

Nest productivity (estimated by the number of young in the nest approximately 1 week prior to fledging; Steenhof 1987) for Queen Charlotte Goshawks on Vancouver Island was 1.7 ± 0.1 (n=95 breeding events) (McClaren 2001a). The mean nest productivity varied significantly from year to year within the same nest areas, but varied little among nest areas. This suggests that prey availability and weather are key factors influencing Queen Charlotte Goshawk reproduction (McClaren *et al.* 2002). Mean nest productivity values could not be calculated for nests in the Queen Charlotte Islands because sample sizes were too small, but for one to two active nests per year over four years, nest productivity ranged from 0 – 2 young (Chytyk and Dhanwant 1999). In southeast Alaska, a mean number of two young fledged per nest attempt (McGowan 1975).

Estimating nest productivity is laborious and costly using broadcast surveys to annually locate active nests. Because Queen Charlotte Goshawks often use alternative nests within nest areas, checking known nests doesn't always accurately indicate nest area activity levels. Birds that are using unknown alternative nests must be located using broadcast surveys or radio telemetry. However, productivity may be overestimated, and nest area occupancy may be underestimated by broadcast surveys because early nest failures may be missed (Steenhof 1987, McClaren 2001b). Furthermore, detection rates of breeding birds in coastal forests is approximately 70% (McClaren 2001b) and individuals whose nests fail, are unlikely to respond to broadcast calls (Kennedy and Stahlecker 1993). On Vancouver Island and in southeast Alaska, the likelihood of missing early nest failures has been reduced because known nest areas are checked each year and most alternative nests within these nest areas have been identified. As well, radio telemetry has been used in combination with broadcast surveys to locate active nests.

Using the number of fledglings per nest to evaluate habitat quality for Queen Charlotte Goshawks is questionable as they are long-lived birds and may only initiate nests when conditions are favourable for breeding. This means that there may be inherently low variation in this demographic parameter (McClaren *et al.* 2002), and that survivorship data must be examined in conjunction with productivity to effectively evaluate population trends for Queen Charlotte Goshawks. As Franklin *et al.* (2000) demonstrated for California Spotted Owls, habitat features beneficial for Queen Charlotte Goshawk reproduction may differ from those features beneficial for their survival.

Adult and juvenile survivorship information is scarce for Queen Charlotte Goshawks. In southeast Alaska, Iverson *et al.* (1996) estimated survivorship of radio-tagged adults (sexes combined) to be 0.72 (n = 39; 95% CI = 0.56 – 0.88) between July 1992 and August 1996. The annual survival rate of juveniles has not been estimated for Queen Charlotte Goshawks. Radio telemetry data for adults from Vancouver Island suggest that individuals have high overwinter mortality rates (McClaren 2001a). Most individuals recovered dead appeared to have died from starvation. However, these survival estimates may be biased high due to the possibility of ele-

vated mortality induced by the extra weight of the radio transmitters. Although evidence is lacking on the effects of backpack transmitters on goshawk survival throughout North America and Europe, it is a concern for radio telemetry studies. Estimating survivorship rates through band-resight data for Queen Charlotte Goshawks is probably unrealistic given the low nesting densities, relatively high breeding dispersal rates by females, and the remoteness of study areas.

Considering the high responsibility British Columbia has for this subspecies, as well as the perceived threat to its habitat, on-going research and monitoring of Queen Charlotte Goshawk populations and their habitat appears necessary if we are to retain it as part of our Canadian avifauna.

References

Chytyk, P., J. Cooper and K. Dhanwant. 1997. *1997 northern goshawk population inventory of the Queen Charlotte Islands Haida Gwaii: Pre-nesting standwatch surveys.* Draft Rep. prepared for Min. Environ., Lands and Parks, Smithers, B.C.

Chytyk, P. and K. Dhanwant. 1999. *1998 Northern Goshawk (Accipiter gentilis laingi) population inventory of the Queen Charlotte Islands/Haida Gwaii.* Unpubl. rep. for Min. Environ., Lands and Parks, Smithers, B.C. 41 pp.

Cooper, J.M. and P. Chytyk. 2000. *Draft status report on the Queen Charlotte goshawk Accipiter gentilis laingi in Canada.* Committee on the Status of Endangered Wildlife in Canada, Ottawa, Canada.

Cooper, J.M. and V. Stevens. 2000. *A review of the ecology, management and conservation of the northern goshawk in British Columbia.* Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Bull. B-101.

DeStefano, S. 1998. *Determining the status of Northern Goshawks in the west: is our conceptual model correct?* J. Raptor Res. 32:342-348.

Ethier, T.J. 1999. *Breeding ecology and habitat of northern goshawks (Accipiter gentilis laingi) on Vancouver Island: a hierarchical approach.* M.Sc. Thesis, Univ. of Victoria, Victoria, B.C.

Franklin, A.B., D.R. Anderson, R.J. Guttiérrez, and K.P. Burnham. 2000. *Climate, habitat quality, and fitness in Northern Spotted Owl populations in northwestern California.* Ecological Monographs 70:539-590.

Hofslund, P.B. 1973. *An invasion of goshawks.* Raptor Res. 7:107-108.

Iverson, G.C., G.D. Hayward, K. Titus, E. Degayner, R.E. Lowell, C.D. Crocker-Bedford, F.P. Schempf, F. Philip, and J. Lindell. 1996. *Conservation assessment of the northern goshawk in southeast Alaska.* U.S. Dept. of Agric., For. Serv., Pacific Northwest Res. Stat. PNW-GTR-387.

Kennedy, P.L. 1997. *The northern goshawk (Accipiter gentilis atricapillus): is there evidence of a population decline?* J. Raptor Res. 31:95-106.

Kennedy, P.L. and D.W. Stahlecker. 1993. *Responsiveness of nesting Northern Goshawks to taped broadcasts of three conspecific calls.* J. Wildl. Manage. 57: 249-257.

Levesque, P.G. 2002. *Northern goshawk, Accipiter gentilis laingi, population inventory summary for Vancouver Island, British Columbia 2001/2002.* Min. Environ., Lands and Parks, Nanaimo, B.C.

McClaren, E. 1997. *"Queen Charlotte" goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia (1996/1997).* Min. Environ., Lands and Parks, Nanaimo, B.C.

McClaren, E. 1998. *"Queen Charlotte" goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia (1997/1998).* Min. Environ., Lands and Parks, Nanaimo, B.C.

McClaren, E. 1999. *Queen Charlotte goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia (1998/1999).* Min. Environ., Lands and Parks, Nanaimo, B.C.

McClaren, E. 2000. *Northern goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia (1999/2000).* Min. Environ., Lands and Parks, Nanaimo, B.C.

McClaren, E.L. 2001a. *Northern goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia (2000/2001).* Min. Environ., Lands and Parks, Nanaimo, B.C.

McClaren, E.L. 2001b. *Factors influencing northern goshawk detectability and reproduction on Vancouver Island, B.C.* Thesis, Colorado State Univ., Fort Collins, CO.

McClaren, E.L., P.L. Kennedy, and S.R. Dewey. 2002. *Do some northern goshawk nest areas consistently fledge more young than others?* Condor 104:343-352.

McGowan, J.D. 1975. *Distribution, density, and productivity of goshawks in Interior Alaska.* Alaska Department of Fish and Game, Fed. Aid Wildl. Rest. Proj. Rep. W-17-4, W-17-5, W-17-6, Job 10.6R, Juneau, AK. 31 pp.

Mueller, H.C., and D.D. Berger. 1967. *Some observations and comments on the periodic invasions of goshawks.* Auk 84:183-191.

Mueller, H.C., D.D. Berger, and G. Allez. 1977. *The periodic invasions of goshawks.* Auk 94:652-663.

North, M., G. Steger, R. Denton, G. Eberlein, T. Munton, and K. Johnson. 2000. *Association of weather and nest-site structure with reproductive success in California spotted owls.* J. Wildl. Manage. 64:797-807.

Steenhof, K. 1987. *Assessing raptor reproductive success and productivity.* In "Raptor management techniques manual" (B.A. Giron Pendleton, B.A. Milsap, K.W. Cline, and D.M. Bird, eds.). Scientific and Tech. Ser. No. 10, National Wildl. Fed., Washington, D.C.

Titus, K., C.J. Flatten and R.E. Lowell. 1994. *Northern goshawk ecology and habitat relationships on the Tongass National Forest (goshawk nest sites, food habits, morphology, home range and habitat data).* First An. Proj. Rep. USDA For. Serv., Alaska Dep. Fish and Game, Juneau, AK. Contract 43-0109-3-0272.

Webster, J.D. 1988. *Some bird specimens from Sitka, Alaska.* Murrelet 69:46-48.

Ferruginous and Swainson's Hawks in Saskatchewan: should we worry?

✠ C. Stuart Houston, 863 University Drive, Saskatoon, SK S7N 0J8; houstons@duke.usask.ca

Ferruginous (*Buteo regalis*) and Swainson's Hawks (*B. swainsoni*) are both grassland buteo species that prey predominantly on Richardson's Ground Squirrels (*Spermophila richardsonii*). In the 1820s and 1850s both buteos ranged north to Carlton on the North Saskatchewan River (Houston and Schmutz 1999). The plains were then largely treeless because grass fires swept across them every few years. After European settlement, and breaking of most of the land, the Ferruginous Hawk abandoned nearly half its initial range (Houston and Bechard 1984), but the Swainson's Hawk range has remained unchanged, almost exactly coincident with the range of the Richardson's ground squirrel. Ferruginous Hawks eat adult ground squirrels, but Swainson's Hawks eat juvenile ground squirrels after many of the adults go underground to estivate in early July.

Since 1969 I have studied Ferruginous Hawks each June, visiting a total of 1405 successful nests, 196 failed nests and banding 3376 nestlings. Of those banded birds, 58 recoveries were reported, many from their wintering grounds in Texas and northern Mexico. The main Saskatchewan study area comprises nine Prairie Farm Rehabilitation Administration (PFRA) pastures from Rosetown west to the Alberta border. An ever-increasing number of nests were located on privately-owned land in the general area that extends from Biggar and Macklin south to the South Saskatchewan River. Each pair of this grassland hawk requires about 5 km² of beef-cattle pasture in the study area. Nest trees are an important limiting factor, resulting in high nest site fidelity, such as one used successfully for 32 consecutive years.

There was unexpectedly high productivity among Ferruginous Hawks in the first survey year: the four nests visited in 1969 fledged 18 young (4.5 young/nest). Through 1987, Richardson's ground squirrels were abundant, and Ferruginous Hawk pairs averaged 3.0 young per successful nest (Fig. 11). However, because we avoid nest visits in April and May, we undoubtedly miss an unknown number of failed nests before our first visit; our "minimal failure rate" is likely an underestimate.

In 1988, the ground squirrel population crashed, and remained extremely low through 1996. Ferruginous Hawk nest success dropped from 90% to 80% and young per successful nest dropped to 2.6 for the nine years ending in 1996. The poorest productivity was in 1996, when the nest failure

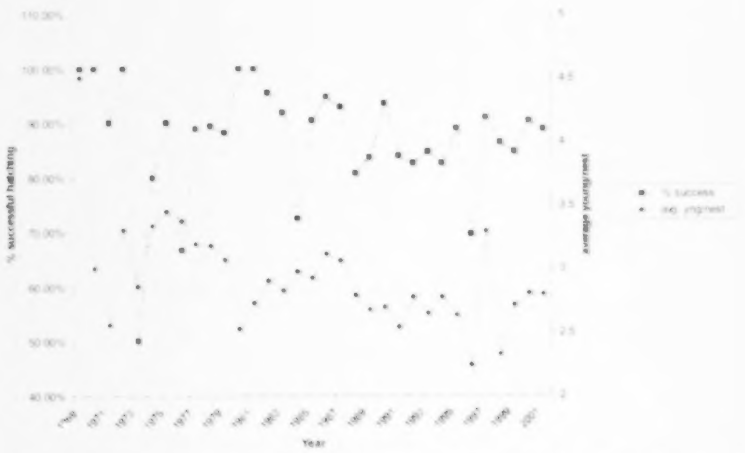


Figure 11. Productivity and success rate for Ferruginous Hawks in Saskatchewan.

rate went up to 30% and productivity per successful nest dropped to 2.2.

In 1997, the vole population exploded across much of Saskatchewan. For this single year, Ferruginous Hawk failure rate dropped to 10% and productivity shot back up to 3.3, before dropping back to 2.8. In contrast to Swainson's Hawks, there has been no apparent drop in the number of nesting pairs of Ferruginous Hawks. Perhaps they suffer less predation from Great Horned Owls, have lower risk on their shorter migration path, or are exposed to fewer toxins on their wintering grounds; perhaps even 2.5 young per nest may be sufficient to maintain the population. Because the Ferruginous Hawk proved to be more common than initially believed, its status was changed from Threatened (Schmutz and Schmutz 1980) to Vulnerable (now Special Concern; Schmutz 1995) by COSEWIC.

In contrast to the Ferruginous, many Swainson's Hawk pairs nest in cropland, and frequently build a new nest each year. Surveys of this species cannot be made before early July, as nest desertion is common if the nest tree is approached before the eggs have hatched.

Since 1971, I have visited 2497 successful nests and 899 failed nests, banding 4581 nestlings; 121 of these were recovered from Argentina, Uruguay and Paraguay, a much longer migration route than that of the Ferruginous Hawk. Swainson's Hawks also had high success through 1987 as long as Richardson's ground squirrels were plentiful (Fig. 12). Again the failure rate is underestimated, though this figure, even in a "good year," can run as high as 45%. Young raised per successful nest averaged well above 2.0 per nest until a drop to 1.6 in the years 1988-1996. As with the Ferruginous Hawk, productivity shot back to a high normal 2.4 in 1997 (the vole year), and then dropped to 1.4 in 1999. Known nest failure rates reached over 60% in 1993 and 54% in 1999. There are now fewer than half as many pairs as were present in the 1970s. Nearly identical results were produced by a study in grassland near Hanna, Alberta (Schmutz *et al.* 2001).

The striking drop in Richardson's ground squirrels was almost entirely a grassland phenomenon. In the mainly dairy-farming areas in parkland near Saskatoon, ground squirrel numbers dropped only slightly and briefly, and Swainson's Hawk nest success and productivity did not drop appreciably. Voles and mice appear to be more common near dairy farms than on open beef-cattle range.

There are no long-term population figures for ground squirrels or voles in Saskatchewan. The red fox was almost unknown

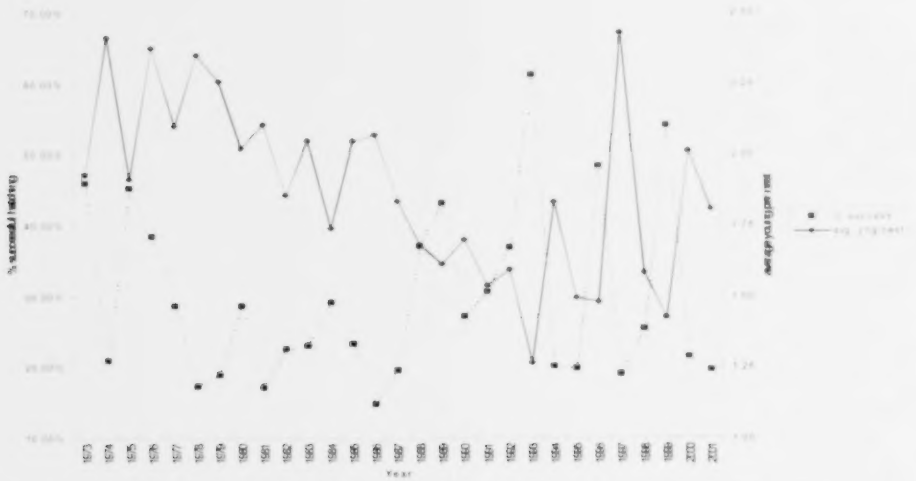


Figure 12. Productivity and success rate for Swainson's Hawks in Saskatchewan.

when we began our study, but increased in the 1970s and reached high numbers in the 1990s. Coyotes have also increased. In 1993 we saw more foxes and coyotes than ground squirrels, a 100-fold reversal of the usual ratio between these species (Schmutz *et al.* 2001). Weather has also played a role; 1988 saw record-setting heat in the first week of June, while 2001 was drier across central Saskatchewan than any previous year, including the 1930s. Few sloughs or ponds remained, and "dugouts" in the pastures went dry in 2001.

Grassland birds have shown greater declines than any other bird guild, with the Burrowing Owl and Sage Grouse in Saskatchewan seemingly headed for extirpation, and Sprague's Pipits and Loggerhead Shrikes showing long-term population declines of 7 and 5% per annum, respectively (Schmutz *et al.* 2001).

Research into the causes of Swainson's Hawk declines is necessary to clarify the issues surrounding the decline of their prey, and whether exposure to chemical toxins on either the wintering grounds or during the breeding season are lowering productivity or causing direct mortality. Until then, these species warrant continued monitoring.

Acknowledgements

Thanks to Jean Harris, from the Kindersley, SK area. Between 1971 and 2001, she located 823 Swainson's nests; from 582 successful nests we banded 1040 nestlings.

References

Houston, C.S. and M.J. Bechard. 1984. *Decline of the Ferruginous Hawk in Saskatchewan*. Am. Birds 38: 166-170.

Houston, C.S., and J.K. Schmutz. 1999. *Changes in bird populations on Canadian grasslands*. Studies in Avian Biology 19:87-94.

Schmutz, J.K., C.S. Houston and S.J. Barry. 2001. *Prey and reproduction in a metapopulation decline among Swainson's Hawks*, Buteo swainsoni. Canadian Field-Naturalist 115: 257-273.

Schmutz, J.K. 1995. *Updated Status Report on the Ferruginous Hawk, Buteo regalis, in Canada*. Committee on the Status of Endangered Wildlife in Canada. 18 pp.

Schmutz, J.K. and S.M. Schmutz. 1980. *Status Report on the Ferruginous Hawk, Buteo regalis, in Canada*. Committee on the Status of Endangered Wildlife in Canada. 30 pp.

Ferruginous Hawk numbers in Alberta: a real decline?

David P. Stepnisky[1], Gary L. Erickson[2], Jamie Iwaasa[3] and Brad Taylor[4]

[1] Department of Renewable Resources, University of Alberta, Edmonton, Alberta T6G 2H1; davids@ualberta.ca; [2] Alberta Sustainable Resource Development, Lethbridge, Alberta T1J 2J8; [3] 11 Heritage Lane West, Lethbridge, Alberta T1K 7S5; [4] 413-14 Street South, Lethbridge, Alberta T1J 2X8

This paper is modified, with permission, from a larger report, available from Alberta Sustainable Resource Development, Fish and Wildlife Division, 7th Floor, OS Longman Building, 6909-116 Street, Edmonton, Alberta, T6H 4P2

The Ferruginous Hawk (*Buteo regalis*) is a migratory hawk that nests in the grassland regions of Canada. As a species of Special Concern in Canada (COSEWIC 2001), and as a threatened species in Alberta (Province of Alberta 1999), it is important to monitor its populations. As with all birds of prey, the success of the Ferruginous Hawk is dependent on its prey and the presence of suitable nesting habitat (Newton 1979). Hence, monitoring data may also be useful in signaling changes in other areas of the ecosystem.

In 1982, a long-term monitoring survey was initiated for Ferruginous Hawks in Alberta. This survey was repeated in 1987, 1992, and most recently in 2000 (Schmutz 1987a, 1993; Taylor and Iwaasa 2000). The goals of this survey are to 1) provide an estimate of population size; 2) document population trends over time; and 3) look at land use in relation to Ferruginous Hawk populations (Schmutz 1993). The study area encompasses a large part of southeastern Alberta, from Consort in the north, west to Calgary, south to the Montana border, and east to the Saskatchewan border (an area approximately 78 000 km^2 in size). The landscape in this area is dominated by an agricultural patchwork of cultivated lands and pasturelands, and remnant areas of native prairie. Blocks (6.8 km by 6.8 km) within the survey area were randomly selected to survey for Ferruginous Hawks. The number of adults, juveniles, and nests were recorded, as well as information on land use (including percent cultivation and presence of oil and gas activity).

The results of the Ferruginous Hawk surveys for Alberta are summarized in Table 7. Based on the average number of nests recorded per plot, an estimate of population size was calculated, assuming that an active nest is representative of one pair of hawks (Schmutz 1982). From 1992 to 2000, the ratio of plots that showed decreases vs. increases (29:7), was significantly different from the 50:50 ratio expected if no change occurred in the population (Binomial Test, $p=0.001$). Although this suggests a decline in 2000, similar low numbers of Ferruginous Hawks were detected in 1982, and these lows may be a function of normal environmental fluctuations.

To determine how land use may be affecting populations of Ferruginous Hawks in Alberta, the number of hawk nests observed in 2000 were compared among blocks with varying levels of cultivation and oil and gas activity. Consistent with previous research in Alberta (Schmutz 1984, 1987b), significantly fewer hawk nests were recorded in blocks with greater levels of cultivation (Fig. 13; Spearman's $r_s=-0.185$, $p=0.09$). Although cultivation appears to have a negative impact on populations of Ferruginous Hawks, it cannot explain the decline observed in 2000, as the average percent of each plot under cultivation has not changed over time (54% in 1987, 49% in 1982, 51% in 1992, and 50% in 2000). Although we hypothesized that oil and gas activity (measured through the presence of oil and gas well-sites or any type of gas station) would result in fewer Ferruginous Hawk nests in those blocks, no significant difference was recorded (Table 8; Mann-Whitney-U, $p=0.827$). This should be interpreted with caution, as oil and gas activity has been reported to result in significantly fewer young being fledged from nests, and abandonment of nests (White and Thurow 1985). Without recording estimates of productivity and nest success, it is unclear what effect oil and gas activity may have on success of the nests observed.

It is difficult to determine if the Ferruginous Hawk decline in 2000 is part of a natural cycle, or cause for concern. Previous research suggests that Ferruginous Hawk numbers tend to rise and fall, in conjunction with their prey populations (Howard and Wolfe 1976, Smith *et al.* 1981, Woffinden and Murphy 1977). In Alberta, hawk numbers and nesting success have been recorded to increase with ground squirrel abundance (Schmutz and Hungle 1989). Although ground squirrel surveys were not completed in conjunction with the 2000 Ferruginous Hawk survey, it is realistic to hypothesize that this may be the driving factor behind the decline (see Houston, p. 29).

In addition to tracking changes in Ferruginous Hawk populations, the survey for Ferruginous Hawks in 2000 was valuable in identifying gaps that need to be addressed by managers interested in this species, and more generally, the grassland

Table 7. The estimated number of pairs of Ferruginous Hawks in southeastern Alberta, 1982-2000[a].

Year	Number of Plots	Study Area (km2)b	Nests per Plot	Range	Estimated No. of Pairs	95%C.I.
1982	80	74 686	0.587	0-7	1059	630-1488
1987	83	77 947	0.94	0-6	1770	1265-2275
1992	63	77 947	0.904	0-7	1702	1181-2223
2000	85	77 947	0.388	0-6	731	365-1097

a 1982-92 data from Schmutz 1993

b An additional 3261 km2 was added to the northwest portion of the survey area in 1

Table 8. Well-site presence in relation to Ferruginous Hawk abundance.

	Number of Plots	Mean No. of Nests/Plot*	Mean No. of Adults/Plot*
Well-site(s) Present	26	0.62 (+/- 0.62)	1.04 (+/- 2.2)
Well-site(s) Absent	59	0.29 (+/- 0.56)	0.58 (+/- 1.13)

*numbers in parentheses are standard deviation

system. Although these 5-year surveys have the potential to track gross changes in the Ferruginous Hawk population of southeastern Alberta, an annual survey would provide better understanding of population fluctuations and possible 'good' and 'bad' years (i.e., population crashes due to storm events). In addition, a consistent and regular system of surveying ground squirrels in the prairies of Alberta would be helpful in understanding their role in driving population changes, as well as in the greater grassland ecosystem. It is critical to have the public and industry involved in management for species like the Ferruginous Hawk that require both pasture and native prairie, so landholder contact should remain a priority. Finally, Ferruginous Hawk research should be directed to fill knowledge gaps, including the effects of oil and gas activity and climate change on Ferruginous Hawk populations.

Acknowledgements

We thank Josef Schmutz (University of Saskatchewan), Gordon Court (Fisheries and Wildlife Management Division), Steve Brechtel (Fisheries and Wildlife Management Division), Sam Barry (Canadian Wildlife Service) and Ursula Banasch (Canadian Wildlife Service) for their encouraging words and recommendations at the onset of the data analysis. Robin Gutsell provided editorial comments. A final thanks goes out to all of the landowners who made this survey possible. This project was completed when the Fisheries and Wildlife Management Division was part of Alberta Environment; this division is now part of Alberta Sustainable Resource Development.

References

COSEWIC. 2001. *Species at risk: Ferruginous hawk.* Http://www.speciesatrisk.gc.ca/Species/English/SearchDetail.cfm?SpeciesID=47

Howard, R.P. and M.L. Wolfe. 1976. *Range improvement practices and ferruginous hawks.* Journal of Range Management 29(1):33-37.

Newton, I. 1979. *Population ecology of raptors.* Buteo Books, Vermillion, SD. 399 pp.

Province of Alberta. 1999. *Wildlife Regulation (Alberta Regulation 143/97).* Queen's Printer. 273 pp.

Schmutz, J.K. 1982. *An estimate of ferruginous hawks in Alberta and the relationship between their density and land use.* Unpubl. Rept. for the Alberta Environmental Research Trust and the Fish and Wildlife Division of Alberta Energy and Natural Resources. Edmonton, AB. 28 pp.

Schmutz, J.K. 1984. *Ferruginous and Swainson's hawk abundance and distribution in relation to land use in southeastern Alberta.* Journal of Wildlife Management 48(4):1180-1187.

Schmutz, J.K. 1987a. *An estimate of population size and probable causes of population stability in ferruginous hawks in southeastern Alberta.* Unpubl. Rept. For Alberta Division of Fish and Wildlife. Edmonton, AB. 41 pp.

Schmutz, J.K. 1987b. *The effect of agriculture on ferruginous and Swainson's hawks.* Journal of Range Management 40(5):438-440.

Schmutz, J.K. 1993. *Population trends of ferruginous hawks in Alberta, including a synthesis for prairie Canada.* Unpubl. Rept. For the Committee on the Recovery of Nationally Endangered Wildlife in Canada (RENEW), Ottawa, On. 21. Pp.

Schmutz, J.K. and D.J. Hungle. 1989. *Populations of ferruginous hawks increase in synchrony with ground squirrels.* Canadian Journal of Zoology 67:2596-2601.

Smith, D.G., J.R. Murphy, and N.D. Woffinden. 1981. *Relationships between jackrabbit abundance and ferruginous hawk reproduction.* Condor 83:52-56.

Taylor, B. and J. Iwaasa. 2000. *2000 ferruginous hawk survey results: foothills fescue natural subregion, preliminary report.* Unpubl. Rept. for Alberta Environment, Natural Resources Service. 12 pp.

White, C.M. and T.L. Thurow. 1985. *Reproduction of ferruginous hawks exposed to controlled disturbance.* Condor 87:14-22.

Woffinden, N.D. and J.R. Murphy. 1977. *Population dynamics of the ferruginous hawk during a prey decline.* The Great Basin Naturalist 37(4):411-425.

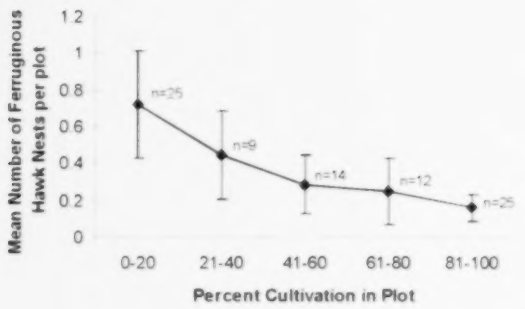


Figure 13. Number of Ferruginous Hawk nests in relation to percent cultivation (bars represent standard error).

Trends in a Migratory Population of Golden Eagle in the Canadian Rocky Mountains

✠ Peter Sherrington, Rocky Mountain Eagle Research Foundation, RR 2, Cochrane, Alberta, T4C 1A2; psherrin@telusplanet.net

Determining the population trends of many species of migratory raptors in the remote areas of northwestern Canada and Alaska is difficult owing to logistic and economic constraints. As a result, there are few standardized regional census or monitoring programs in much of the region (C. McIntyre, pers. comm.). Migration counts are used to monitor broad scale trends in migratory raptors in Sweden (Kjellen and Roos 2000) and in some areas of the western United States (Grindrod and Smith 2000, Smith and Hoffman 2000) and may offer a cost-effective method for monitoring many migratory raptors that breed in northwestern Canada and Alaska (Swem 1985, McIntyre and Ambrose 1999).

Migration studies, however, are potentially limited by such factors as lack of standardization in data collection protocols, the unevenness of observer expertise, the influence of weather on flight direction and intensity, and other factors (Hoffman *et al.* 1992, Dunn and Hussell 1995). If count data are collected consistently, large-scale population trends for some raptor species may be monitored effectively using migration counts (Lewis and Gould 2000). To interpret such data accurately requires an understanding of the underlying population dynamics. Correlating migration data with data from known breeding or source areas may calibrate the migration count and provide insight into how the migration count data reflect changes in breeding populations and productivity: however, these analyses have rarely been attempted.

Although systematic raptor counts in eastern North America date back some 65 years, they only date back to 1977 in the western U.S., and are regularly conducted at only about 14 sites in the Intermountain and Rocky Mountain flyways (Sherrington 2001a, 2001b; Smith and Hoffman 2000). The Mount Lorette count (located in the Kananaskis Valley within the Front Ranges of the Canadian Rocky Mountains, 80km west of Calgary, Alberta) dates from March 1992, when significant numbers of Golden Eagles (*Aquila chrysaetos*) were seen moving through the Front Ranges towards the northwest (Sherrington 1993). Before this time it was generally accepted that Golden Eagle migration occurred almost exclusively through the foothills of the Rocky Mountains (Dekker 1970, Pinel *et al.* 1991, Sadler and Myers 1976). A 33-day count in the fall of 1992 demonstrated that Golden Eagles used the same migratory route to move to the south. By the end of 2001, observers had counted a total of 84 288 migrating raptors of 18 species passing by the Mount Lorette site in fall and spring over a total of 1515 days (14 448 hours). Of this total, 69 678 birds (82.7%) were Golden Eagles and 5977 (7.09%) were Bald Eagles (*Haliaeetus leucocephalus*). The spring total Golden Eagle count is 36 688 (88.37% of the total flight) and the fall count is 37 256 (78.27%). A considerable number of Golden Eagles therefore pass the Mount Lorette site on both fall and spring passage. This allows the opportunity to study the dynamics of a large percentage of a migratory population at the same site in both spring and fall.

Kandyd Szuba © OMNR

To gather the most complete data set possible, observers attempt to record the first and last migrants in a season, and during the height of the migration are at the site from first to last light. This differs from other western sites that have a standard observing period, which is constant from year to year. During 2001, for example, observers were at the Mount Lorette site for 90 days (1037 hours) during the spring, and 101 days (1112 hours) during the fall. Birds are assigned, wherever possible, to the age classes adult, subadult, juvenile, undifferentiated immature and indeterminate age, following criteria in Wheeler and Clark (1995). For the purposes of the following analysis all non-adult birds assigned to an age class are treated as immature.

Fall count data from 1993-2001 show a clear linear diminishing trend from 1993 to 1999, despite steadily increasing observer effort during that period (Fig. 14a). This trend was significantly tempered by the re-

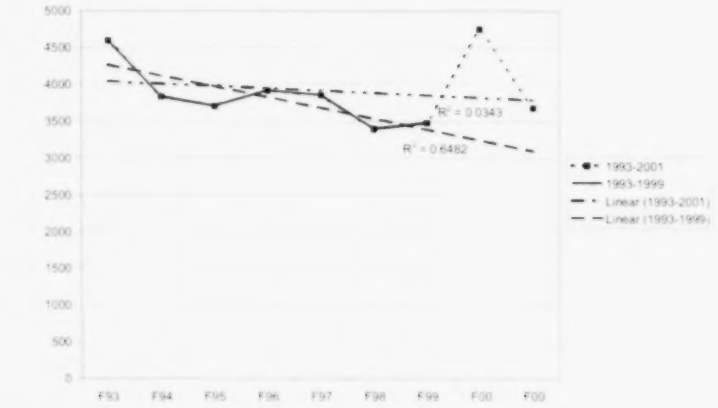


Figure 14a. Mount Lorette Golden Eagle fall counts, 1993-2001.

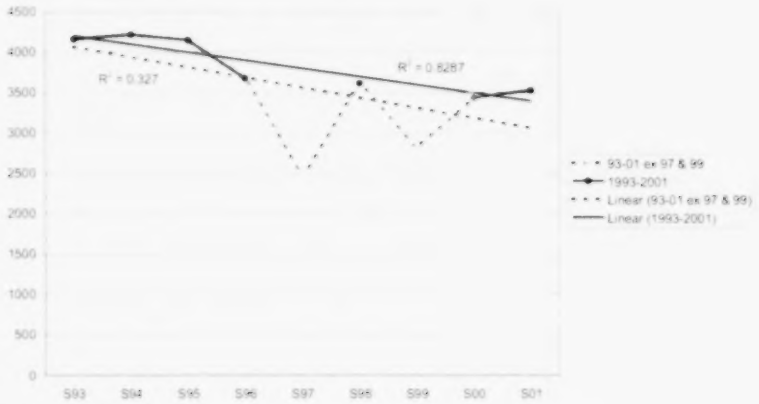


Figure 14b. Mount Lorette Golden Eagle spring counts, 1993-2001.

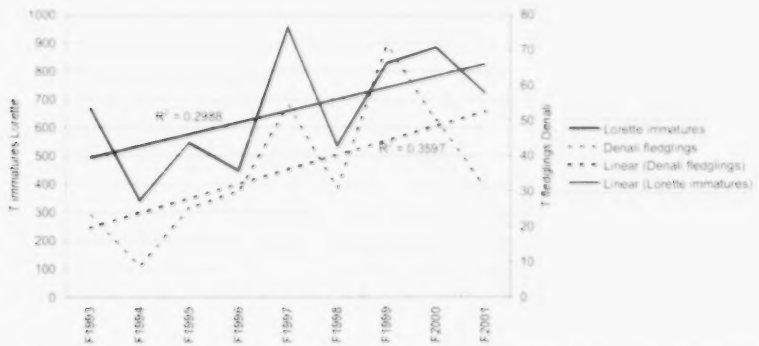


Figure 15. Comparison of number of Golden Eagle fledglings from Denali National Park with counts of immature Golden Eagles from Mount Lorette,1993-2001.

cord count of 4753 birds in 2000. The spring counts (Fig.14b) also show a strong linear decrease throughout the period, even when the anomalously low years of 1997 and 1999 are eliminated. These low counts are probably weather related, with higher than average numbers of birds being deflected to the east and moving through the foothills (W. Smith, pers. comm.)

In contrast to the apparent declining trend in total count numbers, the number of fall immature birds has increased (Fig. 15). Counts of immature Golden Eagles at Mount Lorette are highly correlated with the productivity of 56 to 72 nesting pairs recorded in Denali National Park, Alaska, 2300 km to the northwest (McIntyre and Adams, 1999a; Figs. 15 and 16). Reproductive success in the Denali population is influenced by fluctuating numbers of prey, principally snowshoe hare (*Lepus americanus*) and Willow Ptarmigan (*Lagopus lagopus*), available to eagles early in the nesting season (McIntyre and Adams 1999b). Population peaks and lows of hares in Denali and Kluane Lake, Yukon occurred during the same years (Boutin *et al.* 1995), suggesting that these prey species fluctuate in synchrony over a large geographic area. The correlation probably indicates that Mount Lorette data reflect broad scale changes in Golden Eagle productivity across a large area.

The overall decline in numbers recorded at Mount Lorette may reflect the winter abundance of northern hares and ptarmigan; as their numbers increase, a progressively larger percentage of the adult Golden Eagle population are able to winter north of the Lorette site. The record passage of Golden Eagles in fall 2000, together with the second highest Northern Goshawk (*Accipiter gentilis*) numbers since 1993, probably reflects a rapid decline in these prey species. Total numbers counted at Mount Lorette are predicted to diminish as these prey species increase in the future.

Trends in age ratios in both spring and fall are very similar and show a steady increase through the period. The average fall ratio of the seven-year period 1994-2001 (0.27) is double that in spring (0.13) suggesting an annual average of 50% immature winter mortality. The annual variability of the fall data, which closely mirrors that in Denali (Fig. 16), is considerably greater than in the spring. This suggests that food availability in the winter range is less variable than in the breeding range, but is perhaps more limited as reflected in the apparently high annual winter mortality of immature birds. The data also indicate an inverse relationship between relatively low production years (e.g., 1996, 1998; Fig. 17), and relatively high ratios of birds returning the following springs, and between high production years (1995, 1997) and low ratios the following spring. This may indicate wintering ranges with a finite carrying capacity with relatively higher numbers of birds dying following higher fledging years. Such a situation does not bode well for the future health of the population. The state of the wintering ranges of juvenile birds from southern Canada, south across the Inter-Rocky Mountains, Rocky Mountain Front, Western Great Plains, New Mexico, Western Texas and northern Mexico, needs to be investigated. Large scale land use changes are occurring in these areas, together with increases in threats including electrocution, illegal shooting and poisoning, and deliberate persecution of prey species such as ground squirrels and prairie dogs.

One of the strongest trends seen in the Mount Lorette data is in the median passage dates (the date by which 50% of the flight has passed) of spring migrants (Fig. 18). The median passage dates for the species and for adult birds nearly coincide, as the first half of the flight is made up overwhelmingly of adult birds. Data for immature birds are not included before 1996 as counts before that year did not extend into May, when a significant percentage of young birds migrate. The linear trends for all three classes are remarkably similar and indicate that the median passage has become earlier by 3 (species and immatures) to 3.5 days (adults) over a period of nine years. These trends do not appear to be related to the wide range of weather conditions experienced at the site during these nine years. They may relate to generally increasing average winter and early spring temperatures throughout the period that result in progressively earlier emergence of Richardson's ground squirrels (*Spermophilus*

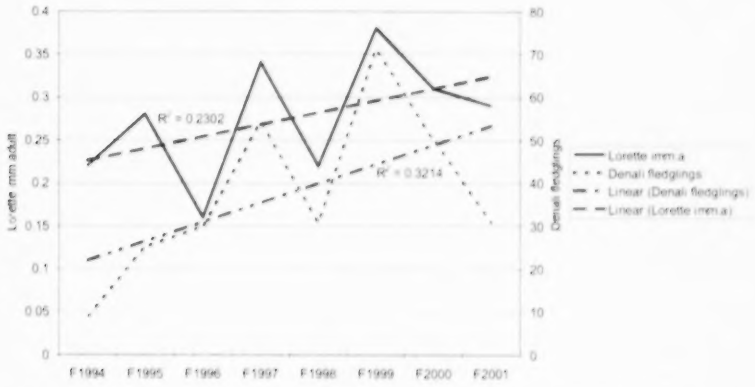


Figure 16. Comparison of number of Golden Eagle fledglings from Denali National Park with immature:adult ratios at Mount Lorette, 1994-2001.

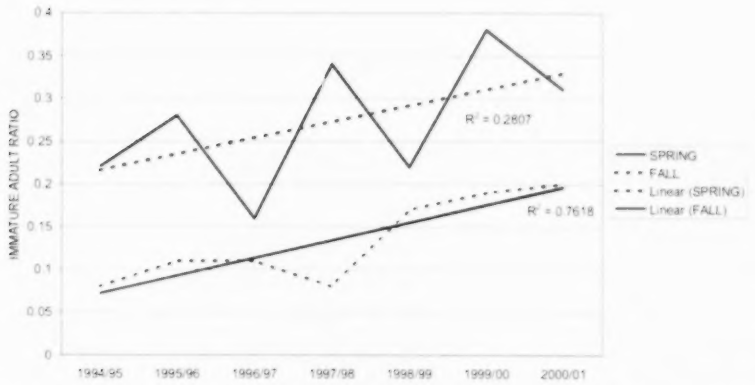


Figure 17. Golden Eagle immature:adult ratios at Mount Lorette, fall 1994–spring 2001.

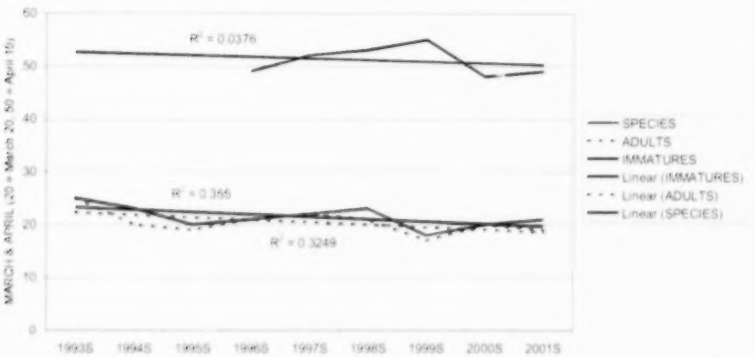


Figure 18. Golden Eagle spring median passage dates at Mount Lorette, 1993-2001.

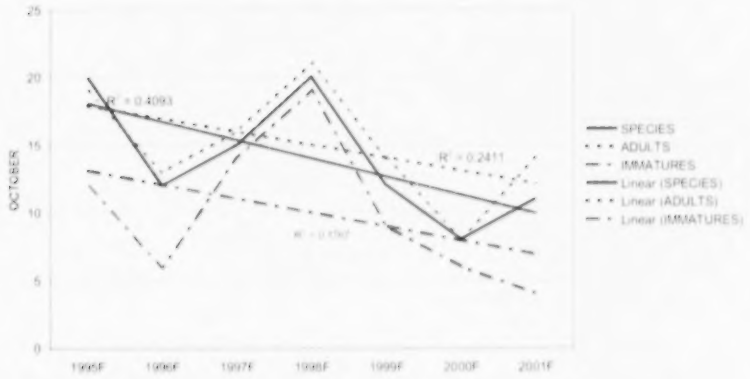


Figure 19. Golden Eagle fall median passage dates at Mount Lorette, 1995-2001.

richardsonii). This species may be a critical food source for adult birds wintering on the western Great Plains enabling them to build up pre-migration body mass in late winter and early spring. Concentrations of adult Golden Eagles have been reported from southern Alberta in late February feeding on ground squirrels newly emerged from hibernation (D. Dolmen, L. Bennett pers. comm.). Fall trends since 1995 (Fig. 19) show a consistent relationship with the median dates of immature birds occurring earlier than those of the species and adult birds, and all three showing linear trends indicating progressively earlier passage during the period.

Because of the standardized methods used, and the correlation to productivity studies in Denali, migration counts of Golden Eagles at Mount Lorette appear to provide meaningful population trend information on this northern species. Extending the data set through future migration counts should improve our understanding of the population dynamics of this species.

References

Boutin S., C.J. Krebs, M.R.T. Dales, S.J. Hannon, K. Martin, A.R.E. Sinclair, J.N.M. Smith, R. Turkington, M. Blowe, A. Byrom, F.I. Doyle, D. Hik, L. Hoefer, A. Hubbs, T. Karels, D.L. Murray, V. Nams, M. O'Donoghue, C. Rohner, and S. Schweiger. 1995. *Population changes of the vertebrate community during a snowshoe hare cycle in Canada's Boreal Forest*. Oikos 74: 69-80.

Dekker, D. 1970. *Migrations of diurnal birds of prey in the Rocky Mountain Foothills west of Cochrane, Alberta*. Blue Jay 28(1).

Dunn, E.H and D.J.T. Hussell. 1995. *Using migration counts to monitor landbird populations: review and evaluation of current status*. Pp. 43-88 *In* "Current Ornithology, Vol. 12" (D.M. Power, ed.). Plenum Press, New York.

Grindrod, P. and J. Smith. 2000. *Migration counts indicate broad-winged hawks are increasing in the West: Evidence of breeding range expansion?* Raptor Watch 14: 8-9. HawkWatch International, Salt Lake City, Utah.

Hoffman, S.W., W.R. DeRagon and J.C. Bednarz. 1992. *Patterns and recent trends in counts of migrant hawks in western North America 1977-1991*. HawkWatch International: 1-2. Salt Lake City, UT.

Kjellen, N. and G. Roos. 2000. *Population trends in Swedish raptors demonstrated by migration counts at Falsterbo, Sweden, 1942-1997*. Bird Study 487: 195-211.

Lewis, S.A. and W.R. Gould. 2000. *Survey effort effects on power to detect trends in raptor migration counts*. Wildlife Society Bulletin 28: 317-329.

McIntyre, C.L., and L.G. Adams, 1999a. *Reproductive characteristics of migratory golden eagles in Denali National Park, Alaska*. Condor 101: 115-123.

McIntyre, C.L., and L.G. Adams, 1999b. *Reproductive success of migratory golden eagles* (Aquila chrysaetos) *in Denali National Park, Alaska*. Condor 101: 115-123.

McIntyre, C.L and R.E. Ambrose. 1999. *Raptor migration in autumn through the Upper Tanana Valley, Alaska*. Western Birds 30: 33-38.

Pinel, H.W., W.W. Smith and C.R. Wershler. 1991. *Alberta Birds, 1971-1980. Volume 1, Non-Passerines*. Provincial Museum of Alberta Natural History Occasional Paper No. 13.

Sadler T.S. and M.T. Myers. 1976. *Alberta Birds, 1961-1970*. Provincial Museum of Alberta Natural History Occasional Paper No. 1.

Sherrington, P. 1993. *Golden eagle migration in the Front Ranges of the Alberta Rocky Mountains*. Birders Journal 2 (4): 195-204.

Sherrington, P. 2001a. *Western Mountain Continental Flyway*. HMANA Hawk Migration Studies 26 (2). Spring 2000 Flyway Reports: 46-68.

Sherrington, P. 2001b. *Western Mountain Continental Flyway*. HMANA Hawk Migration Studies 27 (1). Fall 2000 Flyway Reports: 35-80.

Smith J.P. and S.W. Hoffman. 2000. *The value of an extensive raptor migration monitoring network in western North America*. Pp. 597–615 *in* "Raptors at Risk: Proceedings Vth World Working Group on Birds of Prey and Owls, Midrand, Johannesburg, South Africa, August 1988" (R.D. Chancellor and B.-U. Meyburg, eds.). World Working Group on Birds of Prey and Owls, Berlin, Germany, and Hancock House Publishers, British Columbia and Washington.

Swem, T. 1985. *Sitkagi Beach raptor migration study, spring 1982*. Pp 13-26 *In* "Proceedings of Hawk Migration Conference IV", M. Harwood (ed.). Hawk Migration Association of North America, Rochester, NY.

Wheeler, B.K. and W.S. Clark. 1995. *A Photographic Guide to North American Raptors*. Academic Press, London and San Diego.

Acknowledgments

Carol McIntyre generously provided unpublished data from Denali National Park, and offered many useful comments on an earlier draft of the paper. Thanks to co-observers at Mount Lorette without whom the count would be much less complete. The James L. Baillie Memorial Fund provided a 2001 field season grant.

Table 9. Trend[1] in diurnal raptor populations counted by the Tadoussac Bird Observatory, 1993-2000.

Species	Trend	98% Confidence Intervals[2] Lower Limit	Upper Limit
Osprey	0.0699	-0.42	0.23
Bald Eagle	0.1558	-0.03	0.36
Northern Harrier	0.012	-0.30	0.27
Sharp-shinned Hawk	0.0481	-0.12	0.18
Northern Goshawk	0.0259	-0.14	0.19
Broad-winged Hawk	0.0953	-0.27	0.28
Red-tailed Hawk	0.0593	-0.20	0.32
Rough-legged Hawk	0.0207	-0.32	0.36
Golden Eagle	0.0276	-0.21	0.23
American Kestrel	0.0596	-0.26	0.22
Merlin	0.0496	-0.11	0.38
Peregrine Falcon	0.0784	-0.18	0.20

[1]Calculated using Poisson regression of the number of individuals observed per year and the natural log of survey effort in offset.

[2]Confidence intervals based on 1000 replicates of coefficients of bootstrap regression.

Trends in birds of prey in Quebec

Jacques Ibarzabal, Tadoussac Bird Observatory, Explos-Nature, C.P. 5070, Beauport, QC G1E 6B3; jhawk.ibarzabal@sympatico.ca

Because most raptors are reluctant to cross wide expanses of water (Kerlinger 1989), those migrating south from northwestern Quebec and Labrador collect along the imposing mass of the St. Lawrence River. Daily counts of diurnal raptors have been made each fall since 1993 by the Tadoussac Bird Observatory at Baie-du-Moulin-Baude, in the Saguenay National Park. While the narrowing of the estuary above Tadoussac (< 20 km) might encourage many raptors to cross the St. Lawrence, it also limits the quality of the counts. This paper presents the first analyses of these data.

Two methods were used for trend analysis – simple linear regression and Poisson regression (Bélisle *et al.* 2001). Since results were similar for both, only the results from the Poisson regression are presented here. Over the eight-year survey period, none of the diurnal raptors analyzed showed significant trends (Table 9). The Bald Eagle was the only species whose trend approached statistical significance, showing an increase.

Some caveats should be mentioned in relation to these analyses. First, eight years is a relatively short time period over which to analyze population trends, especially given the cyclic nature of changes in some raptor populations. Second, many other factors may have influenced analyses, among them weather conditions, observer differences, variation in survey effort, and missing observations (Link and Sauer 1998, Lewis and Gould 2000). While attempts were made to control for these factors, little is known about natural population fluctuations in the boreal and sub-arctic regions. In short-term datasets, such as this one, large annual variation in numbers skew the results without reflecting a real population decline or increase (Bélisle *et al.* 2001). It is important, therefore, to obtain more information on the period and duration of any population cycles to improve future population trend models.

Continued monitoring of diurnal raptors at the Tadoussac Bird Observatory is important because of its strategic location for monitoring northern raptor populations, in particular eastern populations of Northern Goshawk, Rough-legged Hawk and Golden Eagle. Gathering a longer series of data at Tadoussac will allow improvements in analysis methods to refine our interpretation of raptor population trends.

Acknowledgements

Thanks to Claude Auchu and Christiane Girard for their interest and diligent field work. Thanks also to Marc Bélisle, Louis Imbeau and Marc Mazerolle for statistical analyses of data. This work would not be possible without the financial support of its partners, including the Quebec Wildlife and Parks Society, Saguenay Park, Canadian Wildlife Service, the Working Boreal Forest Research Group at the University of Quebec (Chicoutimi), the Quebec Wildlife Foundation, the Quebec Association of Bird Clubs, the Alfred B. Kelly Memorial Fund, the Society for the Protection of the Birds of Quebec, and the James L. Baillie Memorial Fund administered by Bird Studies Canada.

References

Bélisle, M.L. Imbeau, and M.J. Mazerolle. 2001. *Dénombrements de rapaces diurnes par l'Observatoire d'oiseaux de Tadoussac: recommandations pour l'analyse statistique des tendances de populations.* Observatoire d'oiseaux de Tadoussac. Programme de recherche de Explos-Nature. Available on request as PDF (jhawk.ibarzabal@sympatico.ca)

Kerlinger, P. 1989. *Flight strategies of migrating hawks.* University of Chicago Press, Chicago, Illinois.

Lewis, S.A. and W.R. Gould. 2000. *Survey effort effects on power to detect trends in raptor migration counts.* Wildlife Society Bulletin 28 :317-329.

Link, W. A., and J.R. Sauer. 1998. *Estimating population change from count data: Application to the North American Breeding Bird Survey.* Ecological applications 8 : 258 - 268.

North American nocturnal owl monitoring: a volunteer-based initiative

Lisa Takats Priestley, Bird Studies Canada, Edmonton, AB T6B 2X3, lisa.priestley@ec.gc.ca

Information on distribution, abundance, and population trends of all North American bird species is critical for developing sound conservation strategies, identifying species in need of particular conservation action, and evaluating the effectiveness of current management programs. Although many long-term monitoring programs are in place (e.g., Breeding Bird Survey, Migration Monitoring, and Christmas Bird Counts), most species of nocturnal owls are poorly monitored by existing multi-species surveys.

Because owls vocalize to communicate with their mates and delineate territory (Johnsgard 1988), imitating or broadcasting recordings of owl vocalizations can evoke vocal responses from many species of owls (Mosher and Fuller 1996). This survey technique has been used to document the range and status of several owl species in North America (Duncan and Duncan 1997), and can also be used to determine habitat associations (Lehmkuhl and Raphael 1993, Mazur 1997, Duncan and Kearns 1997, Takats 1998a).

Following a Canadian workshop on nocturnal owl monitoring (Holroyd and Takats 1997) agreement was reached on a set of standard components that should be incorporated into roadside surveys for breeding owls.

Guidelines for survey protocol are designed to achieve broad scale monitoring of relative abundance, distribution, habitat use, and changes in these parameters over time. They include:

- randomly select routes to ensure that they are representative of the area being surveyed (within the constraints of a roadside survey);
- design routes to consist of at least 10 stations, spaced at least 1.6 km apart, that can be surveyed in a single night;
- survey routes once per year at the time when the majority of species in the region are most active vocally;
- georeference the starting position, and preferably all stations along a route to allow linking of owl records to locations for habitat analysis;
- start the survey at each station with a two-minute silent listening period;
- use playback at a station if target species of owls are known to respond well;
- design field data forms so that the time intervals during which each owl is detected can be recorded (i.e., before or after playback of various species);
- record the approximate direction of and distance to the first detection location of each owl.

Owl Monitoring Program Contacts

Atlantic Provinces

Becky Whittam, Bird Studies Canada, c/o CWS, P.O. Box 6227, 17 Waterfowl Lane, Sackville, NB E4L 1G6, tel (506) 364-5047; becky.whittam@ec.gc.ca

Ontario

Debbie Badzinski, Bird Studies Canada, P.O. Box 160, Port Rowan, ON N0E 1M0, tel (519) 586-3531; dbadzinski@bsc-eoc.org

Manitoba

Jim Duncan, Manitoba Conservation, Box 24, 200 Saulteaux Crescent, Winnipeg, MB R3J 3W3, tel (204) 945-7465; jduncan@nr.gov.mb.ca

Saskatchewan

Alan R. Smith, Environment Canada, 115 Perimeter Road, Saskatoon, SK S7N 0X4, tel (306) 975-4091; alan.smith@ec.gc.ca

Alberta

Lisa Takats Priestley, Bird Studies Canada, c/o CWS, Room 200, 4999-98 Avenue, Edmonton, AB T6B 2X3, tel (780) 951-8901; lisa.priestley@ec.gc.ca

British Columbia

Dick Cannings, Bird Studies Canada, 1330 Debeck Road, S.11, C.96, RR#1, Naramata, BC V0H 1N0, tel (250) 496-4049; dickcannings@home.com

These guidelines will be integrated into the North American Raptor Monitoring Strategy being developed by the U.S. Geological Survey Snake River Field Station, the Raptor Research Foundation and the Boise State University Raptor Research Center (http://srfs.wr.usgs.gov/NARMS.htm).

Several regions in Canada have volunteer-based nocturnal roadside surveys for breeding owls. In British Columbia and southern Yukon, 177 owlers listened at 2072 stops and heard 308 owls of eight species (Cannings 2001). Two years of pilot surveys have been run in Alberta, with 25 volunteers and 30 transects (Takats 1998b). Manitoba's Nocturnal Owl survey had 91 participants who surveyed 57 routes detecting 0.27 owls/station (Manitoba Conservation 2001). In 2001, 172 surveyors participated in the Ontario Nocturnal Owl Survey covering 275 routes (Badzinski 2002). A volunteer owl survey was initiated on Cape Breton Island, Nova Scotia in spring 2000 (Myers, pers. comm.), and 200 Atlantic Canadians ran 104 routes in 2001 (Whittam 2001a, 2001b).

Guidelines for roadside owl surveys are available at: http://www.bsc-eoc.org/owls.html or from the author.

Volunteer-based nocturnal owl monitoring surveys appear to be an effective means of monitoring many species of owls. To participate, please contact the coordinator in your region. For information on setting up a volunteer program or to participate in the national program, please contact the author.

References

Badzinski, D. 2002. *Ontario nocturnal owl survey, 2001 final report*. Bird Studies Canada, Port Rowan Ontario. 18 pp.

Cannings, D. 2001. *The BC nocturnal owl survey 2001*. A newsletter from Bird Studies Canada, Naramata, B.C. 8 pp.

Duncan, J.R. and P.A. Duncan. 1997. *Increase in distribution records of owl species in Manitoba based on a volunteer nocturnal survey using boreal owl (Aegolius funereus) and great gray owl (Strix nebulosa) playback*. Pp. 519-524 *In* "Biology and Conservation of Owls of the Northern Hemisphere" (J.R. Duncan, D.H. Johnson, and T.H. Nicholls, eds.). USDA Forest Service General Technical Report NC-190. St. Paul, MN.

Duncan, J.R. and A.E. Kearns. 1997. *Habitat association with barred owl (Strix varia) locations in southeastern Manitoba: a review of a habitat model*. Pp. 138-147 *In* "Biology and Conservation of Owls of the Northern Hemisphere" (J.R. Duncan, D.H. Johnson, and T.H. Nicholls, eds.). USDA Forest Service General Technical Report NC-190. St. Paul, MN.

Holroyd, G.L. and L. Takats. 1997. *Report on the Nocturnal Raptor Monitoring Workshop*. Pp. 609-611 *In* "Biology and Conservation of Owls of the Northern Hemisphere" (J.R. Duncan, D.H. Johnson, and T.H. Nicholls,eds.). USDA Forest Service General Technical Report NC-190. St. Paul, MN.

Johnsgard, P.A. 1988. *North American owls, biology and natural history*. Smithsonian Institution, Washington, D.C. 295 pp.

Lehmkuhl, J.F. and M.G. Raphael. 1993. *Habitat pattern around northern spotted owl locations on the Olympic Peninsula, Washington*. J. Wildl. Manage. 57:302-315.

Manitoba Conservation. 2001. *Manitoba nocturnal owl survey*. Unpublished data. Winnipeg, MB.

Mazur, K.M. 1997. *Spatial habitat selection by barred owls (Strix varia) in the boreal forest of Saskatchewan, Canada*. MSc. Thesis, University of Regina, Regina, Saskatchewan. 85 pp.

Mosher, J.A. and M.R. Fuller. 1996. *Surveying woodland hawks with broadcasts of great horned owl vocalizations*. Wildlife Society Bulletin 24: 531-536.

Takats, D.L. 1998a. *Barred owl habitat use and distribution in the Foothills Model Forest*. MSc. Thesis, Department of Renewable Resources, University of Alberta, Edmonton, Alberta.

Takats, D.L. 1998b. *Nocturnal owl surveys in the Foothills Model Forest – a model for a volunteer program*. Beaverhill Bird Observatory, Edmonton, Alberta. 10 pp.

Whittam, Becky. 2001a. *New Brunswick Nocturnal Owl Survey, 2001 Annual Report*. Bird Studies Canada - Atlantic Region, Sackville, New Brunswick. 24 pp.

Whittam, Becky. 2001b. *Prince Edward Island Nocturnal Owl Survey 2001 Annual Report*. Bird Studies Canada - Atlantic Region, Sackville, New Brunswick. 20 pp.

Population trends of nocturnal owls in Ontario

Debbie S. Badzinski, Bird Studies Canada, Port Rowan, ON N0E 1M0; dbadzinski@bsc-eoc.org

Owls are considered good indicators of forest health because of their position at the top of the food chain and their dependence on relatively large tracts of forest. However, most owl species are wide-ranging, secretive, primarily nocturnal, and occur at relatively low densities. Consequently, they are not well- monitored by existing programs such as the Breeding Bird Survey and Christmas Bird Count, and little is known about the abundance and population status of most nocturnal owl populations in Canada.

To address this, Bird Studies Canada (BSC), in partnership with several government and non-government organizations and some private corporations, coordinates volunteer roadside nocturnal owl surveys in British Columbia, Ontario and Atlantic Canada. These surveys follow the North

American guidelines for nocturnal owl monitoring (Takats *et al.* 2001), and appear to be an effective means of monitoring several owl species. The British Columbia and Atlantic owl surveys are new (commencing in 2000 and 2001 respectively), whereas the Ontario Nocturnal Owl Survey has collected sufficient data to analyze population trends for some owl species from 1995-2000.

The Ontario Nocturnal Owl Survey, coordinated by BSC in partnership with the Ontario Ministry of Natural Resources' Wildlife Assessment Program, uses a roadside playback protocol targeted at Northern Saw-whet Owl (*Aegolius acadicus*) and Barred Owl (*Strix varia*) in central Ontario, and Great Gray Owl (*Strix nebulosa*) and Boreal Owl (*Aegolius funereus*) in northern Ontario (Badzinski 2002). Lower numbers of five additional owl species (Great Horned Owl [*Bubo virginianus*], Eastern Screech-Owl [*Otus asio*], Long-eared Owl [*Asio otus*], Short-eared Owl [*Asio flammeus*], and Northern Hawk Owl [*Surnia ulula*]) are also recorded on the survey. There are presently sufficient data to calculate population trends for three owl species in central Ontario (Great Horned Owl, Northern Saw-whet Owl, Barred Owl) and five owl species in northern Ontario (Great Horned Owl, Barred Owl, Northern Saw-whet Owl, Great Gray Owl, and Boreal Owl).

Annual population indices were calculated using Poisson regression with a log-link model, treating year and route identifier as class variables (see Badzinski 2002 for more detail). Annual variation in counts was tested by comparing models with and without year effects using a likelihood ratio test. If significant differences were found, contrasts were used to determine which pairs of years differed significantly ($P<0.05$). Power analyses have shown that with the current number of routes, the survey has adequate power to detect major population changes (i.e., 20–30% decline over 2 years) for Barred Owls, Northern Saw-whet Owls and Boreal Owls (Badzinski *et al.* 2001) but not for Great Gray and Great Horned Owls. Popu-

Figure 20. Distribution of routes where the four target species (Barred Owl, Great Gray Owl, Northern Saw-whet Owl, Boreal Owl) were reported (●), and undetected (○), in 2001.

lation trends for each of the five owl species monitored by the survey are summarized below, and their distribution is shown in Figs. 20 and 21.

Boreal Owl. Annual indices for Boreal Owls in northern Ontario differed significantly among years ($P < 0.0001$, Fig. 22). The large decline from 1995 to 1996 was followed by a large increase in 1997, and then further declines in 1998 and 2000. In 2001, the Boreal Owl population index increased significantly exceeding the 1995 index.

Northern Saw-whet Owl. Northern Saw-whet Owl population indices showed high annual variation in both central and northern Ontario, but the variation was more pronounced in the central region (Figs. 22 and 23). In both central and northern Ontario, Saw-whets showed marked population declines in 1996 and 2000. In northern Ontario, the population nearly doubled between 1997 and 1998 then remained fairly stable through 1999. The population then declined significantly in 2000 to the lowest count since the survey began. A similar pattern was observed in central Ontario, except that the annual population index increased substantially in 1999 to levels that approached those of 1995, and then declined to their lowest levels ever in 2000. Saw-whet Owls increased significantly from 2000–2001 in both central and northern Ontario.

Barred Owl. In central Ontario, where they are most effectively monitored, Barred Owl populations have remained quite stable with no significant changes from 1995–2001 (Fig. 23). In northern Ontario, Barred Owl population indices showed significant annual variation ($P<0.05$), but this appears to be due to a relatively high count in 1998, with little change in other years (Fig. 22).

Great Gray Owl. From 1995–1999, numbers of Great Gray Owls in northern Ontario declined to less than half their 1995 levels (Fig. 22). There was a significant decline in 1996 and a significant increase in 1998. In 2000 and 2001, Great Gray Owl

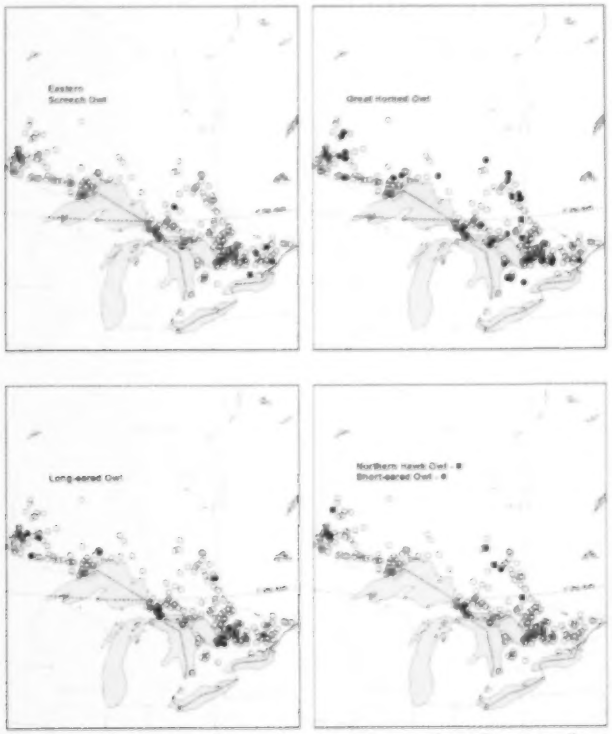


Figure 21. Distribution of routes where non-target species (Eastern Screech Owl, Great Horned Owl, Long-eared Owl, Short-eared Owl, Northern Hawk Owl) were reported (■,●), and undetected (○), in 2001.

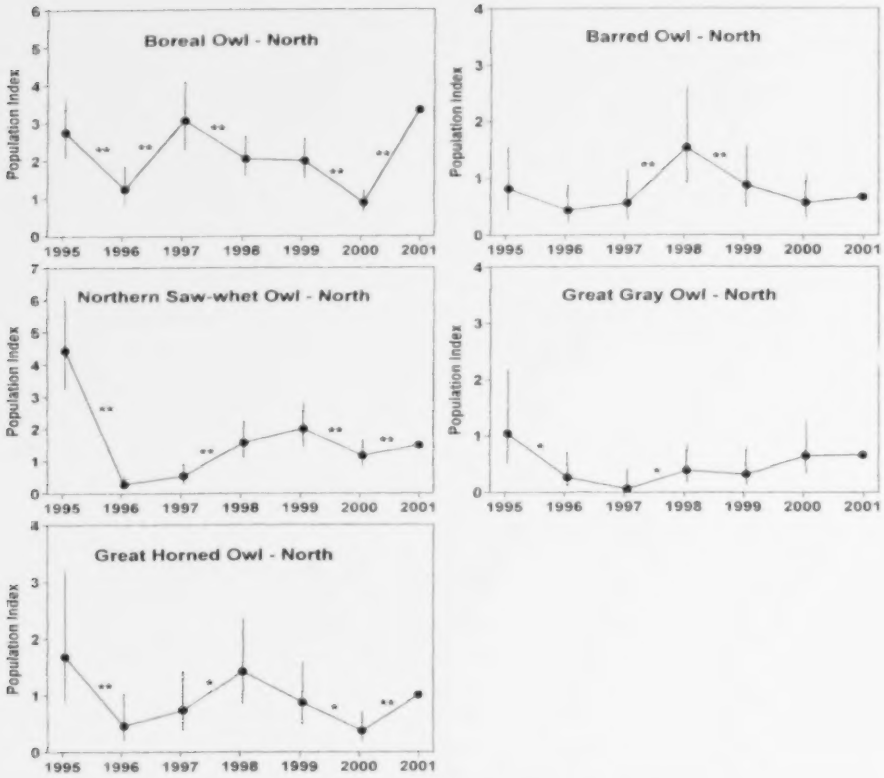


Figure 22. Annual population indices for the five species of owls detected most frequently in northern Ontario. 95% confidence limits refer to differences from 2001, which was chosen as the baseline year. Asterisks indicate significant differences between pairs of years: * $P < 0.05$, ** $P < 0.01$.

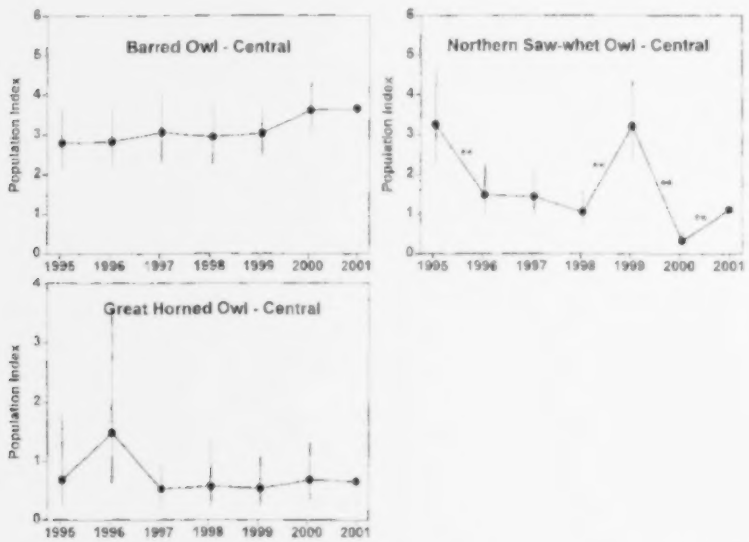


Figure 23. Annual population indices for the three owl species that are detected most frequently in central Ontario. 95% confidence limits refer to differences from 2001, which was chosen as the baseline year. Asterisks indicate significant differences between pairs of years: * $P < 0.05$, ** $P < 0.01$.

numbers increased (non-significantly) but have not quite recovered to 1995 levels. Estimates of Great Gray Owl population changes have very low precision, because this species is detected on few routes and rarely detected on the same route twice.

Great Horned Owl. Numbers of Great Horned Owls showed significant annual variation in northern Ontario but have remained relatively stable in central Ontario (Figs. 22 and 23). In northern Ontario, Great Horned Owls declined significantly from 1995–1996, with a significant increase in 1998. This was followed by a significant decline in 2000 and another increase in 2001. As with the Great Gray Owl, the survey has low power to detect population changes in this species.

Annual fluctuations in owl populations are poorly understood, especially in Ontario, but presumably occur in response to prey availability. It is not known to what extent these annual fluctuations are due to changes in mortality and/or reproductive rates, movement of owls, or changes in behavioural inclination to vocalize. Swengel and Swengel (1997) also found high annual variation in numbers of Northern Saw-whet Owls responding to playback in Wisconsin. However, further research showed that although nocturnal auditory surveys showed large annual variation in number of owls detected, diurnal searches did not. In years with low numbers of calling owls, diurnal searches located many more owls than did auditory surveys. This suggests that annual variation in numbers of Saw-whets (and perhaps Boreal Owls) detected in Ontario may be a function of behaviour as much as the number present. Owl calling frequency may be related to prey abundance and consequently breeding effort. In years with low prey availability, owls may forego breeding and therefore be less territorial and less likely to vocalize. As additional years of data are collected, we should be better able to understand owl population cycles in the future.

© Elaine M. Dickson

References

Badzinski, D.S., C.M. Francis, and B. Whittam. 2001. *Ontario Nocturnal Owl Survey - 2000 Final Report*. Unpublished report by Bird Studies Canada for the Wildlife Assessment Program, Ontario Ministry of Natural Resources. 19 pages.

Badzinski, D.S. 2002. *Ontario Nocturnal Owl Survey - 2001 Final Report*. Unpublished report by Bird Studies Canada for the Wildlife Assessment Program, Ontario Ministry of Natural Resources. 22 pages.

Swengel, A.B., and S.R. Swengel. 1997. *Auditory surveys for Northern Saw-whet Owls (Aegolius acadicus) in southern Wisconsin 1986-1996*. Pp. 411-420 *In* "Biology and Conservation of Owls of the Northern Hemisphere" (J.R. Duncan, D.H. Johnson, and T.H. Nicholls, eds.). USDA Forest Service General Technical Report NC-190. St. Paul, MN.

Takats, D.L., C.M. Francis, G.L. Holroyd, J.R. Duncan, K.M. Mazur, R.J. Cannings, W. Harris, and D. Holt. 2001. *Guidelines for Nocturnal Owl Monitoring in North America*. Beaverhill Bird Observatory and Bird Studies Canada, Edmonton, Alberta. 32 pp.

Estimating Flammulated Owl population trends at the northern range limit

Astrid M. van Woudenberg, Cascadia Natural Resource Consultants Inc., Kamloops, BC V2C 6K7; astrid@cnrc.com

The insectivorous Flammulated Owl (*Otus flammeolus*) is a difficult species to monitor consistently, which in turn makes it difficult to derive population estimates or trends with confidence. Climatic factors, insect activity, time of sampling, and owl breeding behaviour all influence the onset of nesting. Extrapolating population trend information from life history details documented elsewhere in the species' range can be misleading. For example, research results in Colorado (Linkhart 2001) differ from observations of nesting owls in British Columbia. Detailed field investigation, particularly at the northern range limits, is the only accurate way to determine nesting occurrence and population numbers (van Woudenberg and Christie 1997).

Conventional call playback has many limitations in monitoring Flammulated Owls. Calling males are not necessarily indicative of nesting, and a negative response cannot be interpreted as a vacant territory because males are less likely to respond to call playback once they have successfully mated. Call playback should be limited to presence and absence inventories to determine species' range limits and broad distributions, and nesting should be confirmed by locating a female occupying a territory.

The timing of playback surveys also affects their ability to accurately indicate territorial occupancy. Neotropical migrant owls re-

turning to breeding habitats require an adequate food supply to begin nesting. Cold temperatures and precipitation (particularly snow) can result in low nocturnal insect activity, reducing prey abundance for Flammulated Owls and delaying nesting. Owls may track particular insect groups to take advantage of an abundant food supply. For example, Flammulated Owl populations at northern range limits may track western spruce budworm cycles. Spring conditions, as well as those of the past winter, may affect insect cycles, and thereby influence the rate of territory occupancy and nesting chronology.

Furthermore, unsuccessful migration by either the male or female of a territorial pair may result in an unoccupied territory known to have been used in a previous season. Females in Colorado have been shown to have lower success than males in returning to territories (Linkhart 2001). The Colorado results suggest that an even lower success rate could be expected for the northern range limit in British Columbia due to the longer migration these birds undertake.

If localized insect outbreaks can result in high owl productivity, a surplus of birds could occur at the periphery of the range. For example, budworm outbreaks in the Thompson-Nicola areas (Fig. 24) for two consecutive breeding seasons may result in an abundance of birds in the Cariboo-Chilcotin in successive seasons. This fluctuation of birds at the range limit may or may not comprise a nesting population. Interestingly, call playback survey results indicate a lower abundance of calling birds by June throughout the Thompson–Okanagan than in the Cariboo (van Woudenberg 1999), but this could be due to a low response rate following the onset of nesting.

To estimate population trends with any confidence requires documentation of nesting occurrence and success. Nesting success, including recruitment of fledglings to adults, is important in determining source (productive with high recruitment) or sink (non-productive, no recruitment) habitats. Flammulated Owls are strictly nocturnal foragers; therefore, nesting that is delayed as a result of poor prey availability in early spring may not be successful at northern range limits where the nocturnal period is considerably shorter than at lower latitudes. Although insect outbreaks may result in short-term, localized increases in abundance of Flammulated Owl nests, this may attract opportunistic, predatory Barred Owls that dampen any increase in Flammulated Owl populations (pers. obs.). Areas of extreme fluctuations in Flammulated Owl nesting activity could either be sink or source habitats. Currently, there are no data to describe the productivity of potential breeding areas.

Although the Flammulated Owl is one of the smallest North American strigiforms at approximately 55 grams (McCallum 1994), its life history is similar to that of large owls (Linkhart 2001). In Colorado, the Flammulated Owl tends to be long-lived (12 years), has small clutches, never double clutches, has a relatively high nesting success, and males, at least, have high territorial fidelity (Linkhart 2001). Estimating population trends for long-lived species with low fecundity tends to be difficult, because conventional census methods estimate presence/absence, or, at best, densities. Without delineating cohorts or recruitment rates, long-lived adults can mask declining rates in populations.

Population dynamics within the interior of a species' range likely differ from those at its range limits. At its northern range extremes, Flammulated Owls are likely adaptive in their response to environmental and habitat

Figure 24. Distribution of Flammulated Owl habitat in the Cariboo and Thompson-Nicola areas of British Columbia.

change. Nest site monitoring is necessary to determine local population trends. For example, at its northern range limits, Flammulated Owl clutch size may vary more than in the interior portions of its range; clutch sizes of 4 have been observed more often in Kamloops (D. Christie pers. comm.) than in Colorado (Linkhart 2001). Site fidelity may also differ, as banded birds have never been observed in subsequent field seasons in Kamloops, even when the same nest tree has been occupied in successive years (pers. obs., D. Christie pers. comm.). In Colorado, Linkhart observed high nest site fidelity among banded males. Flammulated Owl nestlings have been observed to fledge asynchronously by as much as a week in Kamloops, BC, suggesting a staggered clutch delivery (D. Christie pers. comm.) whereas Colorado birds show synchronous fledging. This difference may indicate variability in the food supply at the species' northern limit.

The low fecundity of the Flammulated Owl (clutch sizes of 2–4; McCallum 1994) and its dependence on old-growth features of dry montane forests compound its inherent vulnerability in sustaining long-term populations. At northern range limits, widely fluctuating climatic conditions likely have an effect on owl population trends, either directly by affecting food supply, indirectly by potentially increasing mortality through energy demands, or, more likely, a combination of both. The differences observed between populations in the interior and at the northern limits of its range may also suggest that populations at the northern limit fluctuate more widely.

If population trends were estimated from the supply of suitable habitat alone, Flammulated Owl populations could be expected to decline over the next century if fire suppression in dry montane forests continues. Increasing densities of small diameter Douglas fir will suppress recruitment of large diameter veteran trees and snags, critical as nest trees. Continuation of increased crowding and forest encroachment may perpetuate the chronic forest health problems in dry forest ecosystems. As well, required foraging habitat features, such as shrub or grassy forest openings, are declining in number and size as encroachment progresses. Currently, there is not enough information about habitat or other parameters to answer critical long-term population questions about the Flammulated Owl.

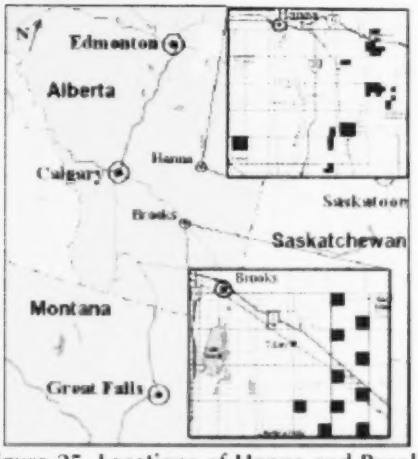


Figure 25. Locations of Hanna and Brooks survey areas in Alberta. Large squares jn insets indicate Townships (~100 km^2). Black squares in insets show areas surveyed for Burrowing Owls.

References

Linkhart, B.D. 2001. *Life history characteristics and habitat quality of Flammulated Owls (Otus flammeolus) in Colorado*. PhD Thesis. U. of Colorado.

McCallum, D.A. 1994. *Review of technical knowledge: Flammulated Owls*. Pp. 14-46. *In*: "Flammulated, Boreal, and Great Gray Owls in the United States: a technical conservation assessment" (G.D. Hayward and J. Verner, eds.). USDA Forest Service Gen. Tech. Rep. RM-253. Fort Collins, CO.

van Woudenberg, A.M. 1999. *Status of the Flammulated Owl in British Columbia*. Wildlife Working Rpt. #WR-95. Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, B.C.

van Woudenberg, A.M. and D.A. Christie 1997. *The Value of Census Results for Interpreting Flammulated Owl Habitat Use in British Columbia*. Pp. 466-476. *In*: "Biology and Conservation of Owls of the Northern Hemisphere" (J.R. Duncan, D.H. Johnson, and T.H. Nicholls, eds.). USDA Forest Service Gen. Tech. Rep. NC-190. St. Paul, MN.

Burrowing Owl population trend surveys in Alberta, 1991-2000

✠ Darcey T. Shyry, University of Alberta, Department of Renewable Resources, Edmonton, AB T6G 2M7; hoverhunter@hotmail.com

Adapted from: Shyry, D.T., T.I. Wellicome, J.K. Schmutz, G.L. Erickson, D.L. Scobie, R.F. Russell, and R.G. Martin. 2001. *Burrowing owl population-trend surveys in southern Alberta: 1991-2000.* J. Raptor Res. 35:310-315.

Evidence from private landowners (e.g., Operation Burrowing Owl/Operation Grassland Community), and individual research projects indicate that Western Burrowing Owl (*Athene cunicularia hypugaea*) populations have declined in every historically occupied province in Canada (Haug and Didiuk 1991, Hjertaas 1997, James *et al.* 1997, Kirk and Hyslop 1998, Shyry *et al.* 2001, Skeel *et al.* 2001, Wedgewood 1978, Wellicome and Haug 1995, Wellicome 1997). Recent monitoring in Manitoba has shown that the owls are essentially extirpated from the province (K. De Smet pers. comm.), while the British Columbia population is generally accepted as extirpated since the 1970s (Howie 1980, Leupin and Low 2001, Wedgewood 1978). Because of population declines, density reductions and breeding range contraction, Burrowing Owls have been listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered since 1995 (Wellicome and Haug 1995). The following is a summary of standardized Burrowing Owl nest surveys in Alberta: six from the Hanna area between 1991 and 2000, and eight in the Brooks area between 1993 and 2001.

Diurnal surveys were first initiated (Schmutz and Wood 1991) in habitat containing >75% native mixed-grass prairie near Hanna in 1991, and near Brooks in 1993 (Fig. 25). Both survey areas are within the historical breeding range of the Burrowing Owl in Alberta. The survey protocol is designed to use call-playback of a territorial male breeding call to locate active nests within a sample of quarter-sections (64.7 ha or 160 acres). Every owl observation was investigated for evidence of nesting including: a) the presence of juvenile owls, b) a pair of owls (pair bonds usually do not endure unless a brood is raised), and/or c) one owl and abundant nesting material (manure or dung), whitewash, pellets, and prey remains present, as well as loosened soil on the burrow mound (Schmutz 1994). Certain weather conditions affect owl behavior (i.e., crouching low in a burrow) and reduce detection of owls. Therefore, surveys were not conducted when: a) temperatures were greater than 30°C (surveys were begun shortly after sunrise and generally did not continue into mid-afternoon), b) wind speeds were greater than approximately 20 km/hr, and/or c) it was raining. Nests found outside of the prescribed survey were not included in this analysis.

Between 1991 and 2000, the number of nests observed in the Hanna surveys de-

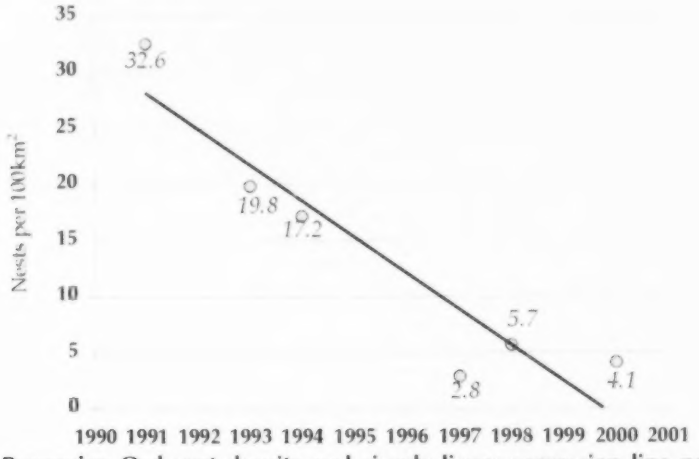


Figure 26. Burrowing Owl nest density and simple linear regression line near Hanna, Alberta, 1991-2000 .

creased substantially, and nest density showed a significant negative trend (Fig. 26; β=-0.94, F=28.1, P< 0.01). The number of nests observed in the Brooks surveys increased between 1993 and 1997, but declined after this peak. There was no significant trend in nest density over time in the Brooks area, but the regression line indicates a slightly positive trend (Fig. 27; β=0.28, F=0.497, P=0.51).

The average nest density in Hanna was higher but was more variable (13.7 nests/100 km^2, SE=4.77, N=6) than in Brooks (8.8 nests/100 km^2, SE=1.21, N=8), resulting from high densities recorded in the first years of the survey. Due to the dissimilar population trends, the Hanna and Brooks surveys were not combined to produce a provincial population trend.

The negative slope of the Hanna regression line corresponds with trends shown over larger areas by population estimates in Saskatchewan (Hjertaas 1997, Skeel *et al.* 2001) and Manitoba (De Smet 1997). The rapidly declining population near Hanna concurs with a northerly contraction of the breeding range, and unless this trend is reversed the local burrowing owl population will likely become extirpated.

Although annual nest densities in Brooks are lower than those from Hanna from 1991-1994, the nest densities in Brooks have not declined substantially over the course of the surveys, and were increasing when the population near Hanna showed its largest declines. The slightly positive slope of the Brooks regression line is the only non-negative population trend known in Canada, but instead of an increasing population it likely represents a fluctuating but relatively stable population. Future surveys may ascertain if the Brooks population remains relatively stable at lower densities (than were determined near Hanna), or if the population will decline as the northern edge of burrowing owl range continues to contract south.

While the reasons for the population decline are not fully understood, intensification of land use has resulted in widespread loss and fragmentation of nesting habitat. The restricted habitat remaining may lead to higher predation or lower productivity from reduced hunting success. These birds may also be more vulnerable to mortality from collisions with vehicles and from pesticide use. Although the migration route and wintering areas for the Burrowing Owl population are not known, there are likely factors in these areas contributing to increased mortality (Hjertaas *et al.* 1995).

Acknowledgements

Surveys were made possible by the sharp observations of G. Court, L. Dube, G. Erickson, K. Grisley, L. Gudmundson, H. Hargrove, J. Hauser, E. Hoffman, J. Kasdorf, R. Lee, C. Marshall, R. Martin, S. Milan, D. Moody, J. Nicholson, R. Russell, J. Schmutz, C. Scobie, D. Scobie, D. Shyry, R. Sissons, J. Smith, J. Taygert, B. Treichel, H. Vriend, T. Wellicome, and D. Wood. Funding for these surveys provided by Alberta Sustainable Resource Development (formerly Alberta Environment). Gracious thanks to the Eastern Irrigation District (Brooks) and the private landowners near Hanna that offer ongoing support to these surveys by providing access to rangelands.

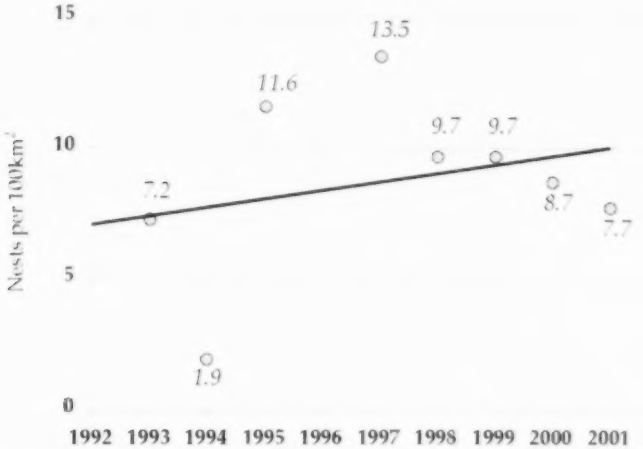


Figure 27. Burrowing Owl nest density and simple linear regression line near Brooks, Alberta, 1993-2001.

References

De Smet, K.D. 1997. *Burrowing Owl (Speotyto cunicularia) monitoring and management activities in Manitoba, 1987-1996.* Pp.123-130. *In* "Biology and conservation of owls of the northern hemisphere" (J.R. Duncan, D.H. Johnson and T.H. Nicholls, eds.). USDA Forest Service General Technical Report NC-190. St. Paul, MN.

Haug, E.A. and A.B. Didiuk. 1991. *Updated status report on the Burrowing Owl in Canada.* Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON, Canada.

Hjertaas, D.G. 1997. *Operation Burrowing Owl in Saskatchewan.* Journal Raptor Research Report 9:112-116.

Hjertaas, D., S. Brechtel, K. De Smet, O. Dyer, E. Haug, G. Holroyd, P. James, and J. Schmutz. 1995. *National Recovery Plan for the Burrowing Owl. Report No. 13.* Ottawa: Recovery of Nationally Endangered Wildlife Committee, 33 pp.

Howie, R.R. 1980. *The Burrowing Owl in British Columbia.* Pp. 85-95 *In* "Threatened and endangered species and habitats in British Columbia and the Yukon" (R. Stace-Smith, L. Johns and P. Joslin, eds.). B.C. Ministry of the Environment, Victoria, B.C.

James, P.C., T.J. Ethier and M.K. Toutloff. 1997. *Parameters of a declining Burrowing Owl population in Saskatchewan.* Journal Raptor Research Report 9:34-37.

Kirk, D.A. and C. Hyslop. 1998. *Population status and recent trends in Canadian Raptors: A Review.* Biological Conservation 83(1): 91-118.

Leupin, E.E. and D.J. Low. 2001. *Burrowing Owl reintroduction efforts in the Thompson-Nicola region of British Columbia.* Journal of Raptor Research 35:392-398.

Schmutz, J.K. 1994. *A census of breeding burrowing owls in southern Alberta: 1994.* Unpublished Report for Alberta Environmental Protection, Edmonton, Alberta.

Schmutz, J.K. and D.W. Wood. 1991. *Determining burrowing owl breeding density in a prairie environment. Final Report.* Unpublished Report for Alberta Environmental Protection, Edmonton, Alberta.

Shyry, D.T., T.I. Wellicome, J.K. Schmutz, G.L. Erickson, D. Scobie, R.F. Russell, R.G. Martin. 2001. *Burrowing Owl (Athene cunicularia) population-trend surveys in southern Alberta: 1991-2000.* Journal of Raptor Research 35(4): 310-315.

Skeel, M.A., J. Keith and C.S. Palaschuk. 2001. *A population decline recorded by Operation Burrowing Owl in Saskatchewan.* Journal of Raptor Research 35(4):371-377.

Wedgewood, J.A. 1978. *The status of the Burrowing Owl in Canada.* Prepared for the Committee on the Status of Endangered Wildlife in Canada. Canadian Wildlife Service, Ottawa, Canada.

Wellicome, T.I. 1997. *Status of the Burrowing Owl (Speotyto cunicularia hypugaea) in Alberta.* Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 11, Edmonton AB. 21pp.

Wellicome, T.I. and E.A. Haug. 1995. *Second Update on the Status of the Burrowing Owl in Canada.* Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Northern Pygmy-Owl inventory of west-central Alberta

M.D. Piorecky and D.R.C. Prescott , Alberta Sustainable Resource Development, Fish and Wildlife Division, Red Deer, AB T4N 6V4; Mark.Piorecky@gov.ab.ca and Dave.Prescott@gov.ab.ca

Three races of the Northern Pygmy-Owl are recognized in Canada. Two of these occur solely in British Columbia. The third, *Glaucidium gnoma californicum*, occurs in the mountainous interior of British Columbia and throughout the mountain, foothill and southern boreal forest regions of Alberta (Godfrey 1986, Hannah 1999). This race of the Northern Pygmy-Owl is not listed as a species of concern in the province of British Columbia (BC CDC 2001), nor has it been designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2001). In Alberta however, the Northern Pygmy-Owl is listed as 'sensitive', which means that it is not believed to be at immediate risk of extirpation or extinction but may require special attention or protection to prevent it from becoming at risk (CESCC 2001). This designation is largely a result of minimal information regarding its distribution, abundance and habitat requirements. This lack of quantitative data is not unique to Alberta. In fact, the Northern Pygmy-Owl is one of the least-studied owls in all North America (Holt and Petersen 2000) and as a result is also listed in several U.S. states (Oregon Dept. of Fish & Wildlife 2002).

© Ilune M. Dickson

Currently there are no estimates of population size or trends for the Northern Pygmy-Owl in Alberta. One reason for this lack of quantifiable data may be that traditional sources of bird abundance and distribution (i.e., Breeding Bird Survey, Christmas Bird Count) are designed to reveal trends of more commonly encountered species. As a result, they capture too few individuals of sparsely distributed species, such as Northern Pygmy-Owls, to provide accurate trend estimates (Sauer *et al.* 1996, Sauer *et al.* 2001). Even in British Columbia where more owls are encountered on both BBS and CBC surveys, sample sizes remain small. Although these data reveal similar minor positive trends (1.3, 1.6 % per year), the results are not significant ($P=0.73$, $P>0.10$) and should be inter-

preted with caution (Sauer *et al.* 1996, Sauer *et al.* 2001). Another reason for the lack of distribution and abundance data may be that, unlike the majority of owls, Northern Pygmy-Owls are diurnal in nature (i.e., most active during daylight hours). Therefore daytime surveys specific to determining Northern Pygmy-Owl presence and abundance must be conducted. These single species surveys are relatively expensive and inefficient collectors of data when compared to multi-species nocturnal owl surveys.

Acknowledging the lack of distribution and abundance information, it is not surprising to learn that little is known about its habitat-use requirements. The Northern Pygmy-Owl is believed to be a habitat and food generalist (Giese 1999). However, it is also an obligate cavity nester relying on natural cavities or those produced by other species for nesting sites (Holt and Petersen 2000). Cavity nesters are of primary interest to the forestry industry because cavities tend to form in older trees. Most forest harvesting programs aim to harvest stands before cavities occur, when fiber quality is at its prime. Without a firm understanding of species habitat requirements at the landscape scale, this practice may lead to the loss of forest age and structure classes required by obligate cavity nesters.

An inventory of west-central Alberta was conducted in an effort to provide critical information on Northern Pygmy-Owl population size, distribution and habitat use. This initiative represents the first concerted effort to survey pygmy-owls over a large part of their range in Alberta. Surveys for Northern Pygmy-Owls ran for eight weeks, commencing in early March to coincide with the onset of breeding activity and ending in early May 2001. Broadcasts of Northern Pygmy-Owl calls were conducted at 1.6 km intervals along accessible roads throughout the eastern slopes. Surveys were initiated with a two-minute silent listening period for spontaneously calling owls. This was followed by approximately 90 seconds of Northern Pygmy- Owl calls, which generally consist of five monotonous toots, spaced 1–2 seconds apart (Johnsgard 1988). Surveys were then concluded with an additional listening period of four-minutes.

During the eight weeks of surveying, 1701 locations were visited. A total of 44 Northern Pygmy-Owls responded to recordings at 43 sites. Of the 43 sites with owls, five were visited twice. Only two of the owls responded on both visits. Two additional sites were visited on three occasions. At one, an owl responded on each visit, while at the other, an owl responded two of three times. The area surveyed was twice as large as originally anticipated, ranging from Hinton to just south of Sundre, and as far east as Rocky Mountain House and Edson, covering all accessible roads in an area of approximately 40 000 km^2. In total over 2720 km of road were surveyed for Northern Pygmy-Owls. With 44 birds responding, a linear density of 0.016 birds/km can be estimated.

What does this means for Northern Pygmy-Owls in Alberta? This survey was the first step in determining distribution and relative abundance of the Northern Pygmy-Owl in west-central Alberta. Our surveys reveal that the species is indeed sparsely distributed across this region. The observed linear density of 0.016 birds/km is nearly 40 times lower than those observed in Arizona and California (0.625 *pairs*/km; Holt and Peterson 2000). Management of this species clearly requires further research into its basic biology, and in particular, population size, trend, distribution, habitat preferences and response to forestry practices. It is hoped that further analysis of our survey data against various physical and spatial habitat attributes will provide habitat-use models that will allow for the prediction of Northern Pygmy-Owl distribution. This in turn will help focus future survey efforts and initiatives aimed at estimating Northern Pygmy-Owl populations and population trends.

References

B.C. Conservation Data Centre (BC CDC). 2001. *2001 Provincial Vertebrate Animal Tracking List*. http://srmwww.gov.bc.ca/cdc/vertebrates.htm.

CESCC. 2001. *Wildspecies 2000: general status of species in Canada*. Canadian Endangered Species Conservation Council. http://www.wildspecies.ca/en/copy_e.html.

COSEWIC. 2001. *Canadian Species at Risk, November 2001*. Committee on the Status of Endangered Wildlife in Canada. 32 pp. http://www.cosewic.gc.ca.

Giese, A.R. 1999. *Habitat Selection by Northern Pygmy-Owls on the Olympic Peninsula, WA*. M.Sc. Thesis, Oregon State University, Corvallis. 34 pp.

Godfrey, W.E. 1986. *The birds of Canada. Rev. ed.* National Museum of Natural Sciences, National Museums of Canada, Ottawa, ON. 595 pp.

Hannah, K.C. 1999. *Status of the Northern Pygmy Owl (Glaucidium gnoma californicum) in Alberta*. Alberta Environmental Protection, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 20, Edmonton, AB. 20pp.

Holt, D. and J. Petersen. 2000. *Northern Pygmy-Owl, (Glaucidium gnoma)*. *In* "The Birds of North America, No. 494" (A. Poole and F. Gill eds.). The Birds of North America, Inc., Philadelphia, PA.

Johnsgard, P.A. 1988. *North American owls: biology and natural history*. Smithsonian Institution, Washington, DC. 295 pp.

Oregon Department of Fish and Wildlife. 1997. Oregon's Sensitive Species-An Explanation. Http://www.dfw.state.or.us/ODFWhtml/InfoCntrWild/InfoCntrWild.html.

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2000. Version 2001.2*. USGS Patuxent Wildlife Research Center, Laurel, MD. http://www.mbr-pwrc.usgs.gov/bbs/bbs.html

Sauer, J. R., S. Schwartz, and B. Hoover. 1996. *The Christmas Bird Count Home Page. Version 95.1*. Patuxent Wildlife Research Center, Laurel, MD. http://www.mbr-pwrc.usgs.gov/bbs/cbc.html

Summary of the 2000 Canadian Peregrine Falcon Survey

✠P. Rowell[1], G.L. Holroyd[2] and U. Banasch[2]

[1] #4 Morgan Crescent, St. Albert, Alberta T8N 2E2; prowell@telusplanet.net; [2] CWS Prairie & Northern Region, Edmonton, Alberta T6B 2X3; Geoffrey.Holroyd@ec.gc.ca; Ursula.Banasch@ec.gc.ca

Three subspecies of Peregrine Falcon (*Falco peregrinus*) occur in Canada (White 1968). The continental *anatum* subspecies breeds south of the treeline from the Atlantic to the Pacific oceans; the northern *tundrius* subspecies nests along arctic rivers, lakes, coastline, and inland escarpments, and the western *pealei* subspecies occupies coastal islands and areas of adjacent mainland British Columbia.

The well-documented decline of peregrine populations started in the late 1940s (Kiff 1988) and was directly linked to contamination by pesticides such as DDT, BHC, dieldrin and heptachlor epoxide (Ratcliffe 1969). In 1978, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) classified *anatum* peregrines as endangered, *tundrius* as threatened and *pealei* as rare (Martin 1979). An *anatum* Recovery Team was formed and implemented a Recovery Plan by 1987 (Erickson *et al.* 1988).

In Canada, researchers began surveying peregrines prior to 1960 (Beebe 1960, Enderson 1965, Fyfe 1969). From 1970 on, national surveys were carried out every five years to determine nest site occupancy and productivity. The 1965 Madison Peregrine Conference and the 1970 and 1975 North American surveys documented the continued downfall of the peregrine (Hickey 1969, Cade and Fyfe 1970, Fyfe *et al.* 1976). In 1980, small, remnant populations were present in northern Quebec, the Northwest Territories and the Yukon, however only one site was occupied in southern Canada (south of 58° N and east of the Rocky Mountains) (White *et al.* 1990). By 1985–86, west coast and northern populations had increased or were stable while small, urban, populations in the south were established through the reintroduction of captive-raised young (Murphy 1990). The 1990 survey again documented stable or increasing populations in the north and west with smaller gains made in the south (Holroyd and Banasch 1996). In 1992, COSEWIC reclassified *tundrius* peregrines as vulnerable (Bromley 1992). In 1995, stable or increasing survey numbers for *anatum* peregrines met initial objectives set previously for six management zones across Canada (Erickson *et al.* 1988, Banasch and Holroyd *in press*). In 1999, *pealei* were retained as species of special concern (COSEWIC 2000) and *anatum* were downgraded from endangered to threatened

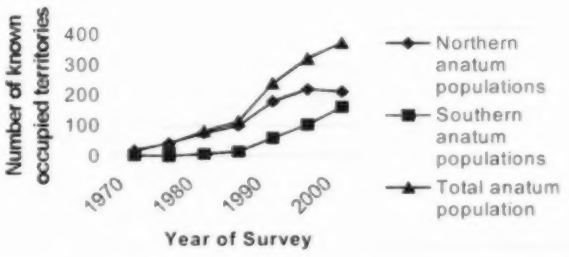


Figure 28. Increase in the number of known occupied territories of *anatum* peregrines, 1970–2000.

Table 10. Total number of sites occupied by Peregrine Falcons in selected regions of Canada, 1965–2000 with number of territorial pairs present in parentheses.

Area	1965-66	1970	1975	1980	1985-86	1990	1995	2000
anatum								
Labrador, Newfoundland	0	2 (2)	0	ND	2 (2)	21 (21)	31 (31)	22 (15)
Bay of Fundy (NS, NB)	ND(2)	0	0	0	1 (1)	7 (5)	6 (6)	11 (11)
Southern Quebec	ND(2)	0	ND	1 (1)	1 (1)	15 (12)	15 (13)	28 (25)
Southern Ontario	0	0	0	0	1 (0)	3 (2)	15 (14)	53 (42)
Southern Manitoba	ND	ND	ND	0	1 (1)	2 (1)	4 (4)	3 (2)
Southern Saskatchewan	ND	0	ND	0	2 (1)	2 (1)	2 (2)	4 (3)
Alberta South of 58°N	8(6)	1 (1)	0	0	2 (2)	3 (3)	13 (12)	23 (23)
Southern Interior, BC		ND	ND	ND	ND	ND	2 (2)	1 (1)
Lower Mainland, BC		ND	ND	ND	ND	ND	8 (8)	6 (5)
Gulf Is. & SE Van. Is., BC	ND	ND	ND	5 (4)[1]	4 (2)	6 (3) [2]	9 7)	11 (9)
Alberta North of 58°N	ND(4)	2 (1)	3 (3)	9 (9)	6 (5)	9 (9)	23 (23)	29 (29)
Porcupine River, Yukon	ND	ND	8 (8)	16 (13)	14 (11)	36 (ND)	29 (29)	35 (35)
Peel River, Yukon	ND	ND	ND	18 (12)	12 (10)	14 (ND)	37 (37)	22 (22)[3]
Yukon River, Yukon	ND	6 (5)	6 (5)	12 (10)	22 (18)	33 (ND)	46 (46)	46 (46)
Southern Lakes, Yukon							1 (1)	ND
Mackenzie Valley, NWT	14(ND)	9 (6)	24 (21)	20 (15)	45 (ND)	88 (77)	83 (83)	80 (80)
Total anatum counted	**22(14)**	**20 (15)**	**41 (37)**	**81 (64)**	**113 (54)**	**239 (134)**	**324 (319)**	**374 (348)**
tundrius								
Ungava Bay, Quebec	ND	12 (9)	11 (9)	10 (10)	23 (23)	34 (34)	ND	ND
North Slope, Yukon	ND	ND	5 (5)	2 (0)	0	1 (0)	5 (5)	9 (7)
Rankin Inlet, Nunavut	ND	ND	ND	8 (8)[4]	26 (ND)	26 (26)	27 (27)	25 (22)
Tuktut Nogait NP, NWT						19 (19) [5]		19 (18)
Total tundrius		**12 (9)**	**16 (14)**	**20 (18)**	**49 (23)**	**80 (79)**	**32 (32)**	**53 (47)**
pealei								
Langara Island, BC	9(6)	6(5)	6 (6)	6 (6)	6 (5)	7 (7)	7 (5)	9 (7)
Queen Charlotte Is., BC	76(55)	56 (46)	60 (51)	73 (58)	50 (ND)	64 (53)	62 (45)	60 (44)
N. Van. & Scott Is., BC	ND	ND	ND	ND	6 (5)	10 (5)	10 (6)	20 (12)
Triangle Island, BC		ND	ND	ND	ND	ND	8 (8)	7 (6)
Total pealei	**85(61)**	**62 (51)**	**66 (57)**	**79 (64)**	**62 (10)**	**81 (65)**	**87 (64)**	**96 (69)**

[1]Gulf Island sites only.

[2]Data was actually collected in 1991.

[3]A smaller section of the Peel was surveyed in 2000 compared to 1995.

[4]Only a partial survey was conducted at Rankin Inlet in 1980 compared to the area surveyed in subsequent years.

[5]Tuktut Nogait data was based on surveys in 1988 and 1990.

ND = No data

(Johnstone 1999). In 2000, the seventh national Peregrine Falcon survey was conducted to continue documenting the population and productivity trends of this recovering species, the results of which are summarized here.

For the 2000 survey, biologists searched 22 areas during the breeding season in nine provinces and three territories. They found 523 sites occupied by 464 (89%) territorial pairs and 59 (11%) territorial singles for a total of 987 adult peregrine falcons.

Anatum

A total of 374 sites were occupied within the range of *anatum* peregrines, 93% of which were occupied by pairs, an increase of approximately 15% since 1995 (Table 10). This figure is somewhat less than the 36% increase observed between 1990 and 1995 (Banasch and Holroyd *in press*). However, a declining rate of increase is to be expected in a recovering population approaching carrying capacity (Fig. 28). Peregrine numbers in the Mackenzie River valley, Yukon drainages and northern Alberta were similar to those recorded in 1995 indicating these regions may be saturated. While the majority (57%) of *anatum* territories were again found in the boreal northwest (Yukon and Northwest Territories and northern Alberta), this proportion has declined from the 1995 survey (68%) due to the large increases in the number of occupied territories in populations south of 58°N. The known population in Southern Ontario has more than tripled (15 to 53) between 1995 and 2000. While some of the increase was due to expanded search effort, at least part of the population growth is attributed to

Table 11. Productivity of Peregrine Falcons in selected regions of Canada surveyed every 5 years, 1970–2000. Productivity data indicate average young fledged per successful pair, with average young fledged per territorial pair in parentheses.

Area	1970	1975	1980	1985-86	1990	1995	2000
anatum							
Labrador	2.0 (2.0)	0	ND	3.0 (1.5)	3.3 (2.6)	2.2 (1.0)	2.4 (1.6)
Bay of Fundy	0	0	0	0	2.0 (1.2)	2.4 (2.0)	2.0 (1.8)
Southern Quebec	0	ND	2.0 (2.0)	0	1.9 (1.4)	2.6 (2.0)	2.3 (1.6)
Southern Ontario	0	0	0	0	2.0 (1.3)	1.5 (1.1)	2.6 (1.6)
Southern Manitoba	ND	ND	0	0	2.0 (1.0)	3.0 (1.5)	4.0 (2.0)
Southern Saskatchewan	0	ND	0	0	1.0 (0.5)	1.5 (1.5)	2.5 (1.7)
Alberta South of 58°N	3.0 (1.5)	0	0	2.0 (2.0)	1.5 (1.0)	3.0 (0.8)	3.0 (2.5)
Southern Interior, BC						ND	ND
Lower Mainland, BC						ND	ND
Gulf Is. & SE Van. Is., BC							ND
Alberta North of 58°N	0	0	3.2 (2.1)	0	2.6 (1.4)	2.8 (2.2)	2.6 (0.7)
Porcupine River, Yukon	ND	ND	1.7 (1.2)	2.6 (2.0)	2.8 (1.7)	2.3 (1.3)	2.1 (1.3)
Peel River, Yukon	ND	ND	0	2.3 (1.9)	3.2 (2.4)	2.1 (0.9)	1.2 (0.6)
Yukon River, Yukon	2.0 (2.0)	1.0 (0.4)	2.2 (1.3)	2.8 (2.2)	2.4 (1.7)	2.7 (1.6)	3.1(1.5)
Southern Lakes, Yukon						3.0 (3.0)	ND
Mackenzie Valley, NWT	2.3 (1.4)	1.3 (0.9)	2.0 (1.5)	2.1 (1.7)	2.6 (2.1)	2.6 (1.8)	2.2 (1.0)
Average	2.3 (1.7)	1.2 (0.7)	2.2 (1.6)	2.5 (1.9)	2.3 (1.5)	2.4 (1.6)	2.5 (1.5)
tundrius							
Ungava Bay, Quebec	1.7 (1.3)	1.8 (1.8)	2.7 (2.7)	3.2 (2.7)	3.1 (2.9)	ND	ND
North Slope, Yukon	ND	ND	0	0	0	2.3 (1.8)	2.1 (2.1)
Rankin Inlet, Nunavut	ND	ND	3.3 (2.9)	1.8 (0.6)	2.5 (0.8)	2.1 (0.7)	2.3 (1.7)
Tuktut Nogait NP, NWT							2.6 (1.0)
Average	1.7 (1.3)	1.8 (1.8)	3.0 (2.8)	2.5 (1.7)	2.8 (1.9)	2.2 (1.3)	2.3 (1.6)
pealei							
Langara Island, BC	2.2 (2.2)	2.4 (2.0)	2.2 (2.2)	2.0 (1.6)	2.8 (2.0)	2.0 (1.7)	1.8 (1.3)
Queen Charlotte Islands, BC	2.5 (ND)	3.2 (ND)	2.5 (2.1)	ND	ND	ND	ND
N. Vancouver Island & Surrounding Islands	ND	ND	ND	ND	ND	ND	ND
Triangle Island, BC						ND	ND
Average	2.4 (2.2)	2.8 (2.0)	2.4 (2.2)	2.0 (1.6)	2.8 (2.0)	2.0 (1.7)	1.8 (1.3)

ND = no data

natural productivity. Other *anatum* populations experiencing positive growth included the Bay of Fundy, southern Quebec and southern Alberta. Labrador peregrines were the only *anatum* population to record a decline in the number of occupied territories in 2000 (see Brazil, p. 56).

Although there was some regional variation, overall *anatum* productivity rates remained similar in 2000 to rates in 1995 (Table 11). Average young per successful pair rose slightly from 2.4 in 1995 to 2.5 in 2000 with particularly good production in successful pairs in the prairie and Yukon River populations. Average young per territorial pair was slightly lower in 2000 (1.5 down from 1.6 in 1995). However, there was a range of highs and lows, particularly in Alberta where the southern population averaged 2.5 young per territorial pair compared to 0.7 young per territorial pair in the north.

Although COSEWIC downlisted *anatum* peregrines in 1999 because extinction was no longer a threat (Johnstone 1999), the subspecies was retained in the threatened category due to the slow growth and uncertain status of populations in the south. The survey in 2000 further verified that most *anatum* sub-populations are either stable or increasing across Canada, but it remains to be seen whether populations in the south are completely self-sustaining. In southern Alberta and Ontario, approximately one-half and one-third (respectively) of all identified adults are still red-banded (captive-raised and released prior to 1997 when release programs effectively ended). These

ratios will decline over the next five years as natural mortality claims this supplemental cohort and as natural production replaces them with peregrines produced in the wild.

Tundrius

The number of occupied territories and the number of territorial pairs in 2000 was similar to previous numbers for stable populations of *tundrius* peregrines at Rankin Inlet and Tuktut Nogait National Park (Table 10). While a larger area was surveyed on the Yukon's north slope, this *tundrius* population is believed to be increasing, although it remains relatively small. *Tundrius* productivity figures were 2.3 young per successful pair and 1.6 young per territorial pair, similar to 1995 figures of 2.2 and 1.3 (Table 11).

Pealei

On the West Coast, the *pealei* population of the Queen Charlotte Islands, including Langara Island, has probably been stable since surveys began (Table 10). Although North Vancouver Island and the surrounding area were surveyed with greater effort in 2000, the large increase in numbers is probably indicative of some population growth. Productivity data is limited for *pealei* peregrines. Results from Langara Island in 2000 (Table 11) indicate a below average year with 1.8 young per productive pair and 1.3 young per territorial pair compared to 2.0 and 1.7 in the 1995 survey.

For the most part, the known peregrine population in Canada appears to be healthy and growing. Although this species is probably approaching carrying capacity in the north, it is obvious that it remains sensitive to annual weather events, forest fires or other natural conditions that affect nesting sites and conditions. In southern Canada, populations are recovering from the lows of the 1970s and are expanding into available urban and rural habitat. Peregrine Falcon population monitoring should continue to ensure this species' recovery is maintained in the future.

Acknowledgements

We gratefully acknowledge the many staff and volunteers who participated in the 2000 survey from coast to coast to coast. Recovery Team members and regional compilers including D. Amirault (CWS-Atlantic Region), M. Elderkin (Nova Scotia Dept. of Natural Resources), J. Brazil (Newfoundland Inland Fish and Wildlife Division), M. Lepage (Société de la faune et des parcs du Québec), T. Armstrong and B. Ratcliff (Ontario Ministry of Natural Resources), T. Maconachie (Manitoba Peregrine Falcon Recovery Project), P. Thompson (Clavet, Saskatchewan), R. Corrigan (Alberta Conservation Association), M. Bradley (Wood Buffalo National Park), G. Holroyd (CWS – Prairie and Northern Region), D. Mossop (Yukon College), S. Matthews and S. Carrière (Northwest Territories Dept. of Resources, Wildlife and Economic Development), M. Chutter (British Columbia Wildlife Branch), D. Abernethy and J. Hunter (Nunavut Dept. of Sustainable Development), G. Court (Alberta Environment) and J. Obst (Tuktut Nogait National Park) submitted and reviewed regional summaries.

References

Banasch, U. and G.L. Holroyd. *In press. The 1995 Canadian peregrine falcon survey.* Occasional Paper Series. Canadian Wildlife Service.

Beebe, F.L. 1960. *The marine peregrines of the northwest pacific coast.* Condor 62:145-189.

Bromley, M. 1992. *Status report on the tundra peregrine falcon* (Falco peregrinus tundrius) *in Canada.* COSEWIC report.

Cade, T.J. and R. Fyfe. 1970. *The North American peregrine survey, 1970.* Can. Field-Nat. 84(3):231-245.

COSEWIC. 2000. *Canadian species at risk, May 2000.* Committee on the Status of Endangered Wildlife in Canada. 23 pp.

Enderson, J.H. 1965. *A breeding and migration survey of the peregrine falcon.* Wilson Bull. 77:327-339.

Erickson, G., R. Fyfe, R. Bromley, G.L. Holroyd, D. Mossop, B. Munro, R. Nero, C. Shank, and T. Wiens. 1988. *Anatum peregrine falcon recovery plan.* Can. Wildl. Serv. Publication. 52 pp.

Fyfe, R.W. 1969. *The peregrine falcon in northern Canada.* Pp. 101-114 in "Peregrine Falcon Populations, their Biology and Decline" (J.J. Hickey, ed.). University of Wisconsin Press, Madison, WI.

Fyfe, R.W., S.A. Temple and T.J. Cade. 1976. *The 1975 North American peregrine falcon survey.* Can. Field-Nat. 90(3): 228-273.

Hickey, J.J. (ed.). 1969. *Peregrine Falcon Populations, their Biology and Decline.* University of Wisconsin Press, Madison, WI.

Holroyd, G.L. and U. Banasch. 1996. *The 1990 Canadian peregrine falcon* (Falco peregrinus) *survey.* J. Raptor Research 30(3): 145-156.

Johnstone, R.M. 1999. *Updated COSEWIC status report on anatum peregrine falcon* (Falco peregrinus anatum). Committee on the Status of Endangered Wildlife in Canada. 47pp.

Kiff, L.F. 1988. *Changes in the status of the peregrine falcon in North America: an overview.* Pp. 123-129 in "Peregrine Falcon Populations: Their Management and Recovery" (T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds.). The Peregrine Fund, Inc., Boise, ID. 949 pp.

Martin, M. 1979. *Status report on peregrine falcon (Falco peregrinus) in Canada*. COSEWIC report., B.C. Fish and Wildlife Branch, Victoria, BC. 45 pp.

Murphy, I.E. 1990. *The 1985-86 Canadian peregrine falcon*, Falco peregrinus, survey. Can. Field-Nat. 104:182-192.

Ratcliffe, D. 1969. *Population trends of the peregrine falcon in Great Britain*. Pp. 239-270 in "Peregrine Falcon Populations: Their Biology and Decline" (J.J. Hickey, ed.). University of Wisconsin press, Madison, WI. 596 pp.

White, C.M. 1968. *Biosystematics of the North American Peregrine Falcons*. Ph.D. dissertation, Univ. of Utah, Salt Lake City.

White, C.M., R.W. Fyfe, and D.B. Lemon. 1990. *The 1980 North American peregrine falcon*, Falco peregrinus, *survey*. Can. Field-Nat. 104(2): 174-181.

The 2001 Peregrine Falcon survey in interior Labrador

✠ Joe Brazil, Inland Fish and Wildlife Division, Department of Tourism, Culture and Recreation, St. John's, NF A1B 4J6; joebrazil@gov.nf.ca

Although a national Peregrine Falcon survey is conducted every 5 years, additional surveys were established in Labrador to detect population changes which may not be picked up by the less frequent national survey. Two survey areas were established that differ significantly in terms of topography, prey, climate and human access. Each area is surveyed by helicopter at least once every two years recording occupancy and productivity. The coastal area has been surveyed 4 times since 1996, and the interior Labrador area has been surveyed annually since 1999.

The interior study area was surveyed between 25–28 July 2001. All sites had previous records of nesting falcons or territorial pairs, and included sites along the Fraser, Kogaluk, and Ikadlivik Rivers, as well as Tasisuak and Cabot Lakes. All run in an east-west direction between 56 and 57 degrees latitude. The rivers have steep sides carved by glaciers out of an interior plateau. Vegetation on the plateau is tundra-like, while the river valleys have low shrubs, mosses, and grasses as well as tundra plants.

Although the cliffs were checked for 1 to 2 kilometers on either side of the 20 sites visited, and additional possible sites were surveyed, only 6 sites had adult peregrines present. Territorial behaviour was exhibited at only 3 of these sites. No chicks or eggs were observed, however it is possible that eggs or chicks could have been missed due to the size of some of the cliff faces. Similar results were obtained in 2000, when only 2 sites had nesting peregrines, but occupancy was significantly higher in 1999 (Table 12).

The cause (or causes) of this dramatic decrease in occupancy cannot be easily determined. The spring and summer weather in 2000 and 2001 seemed to be relatively wet and cold compared to previous years. This may have affected the availability of prey, and subsequently the ability of peregrines to successfully incubate eggs or raise young. Survey dates did differ among years (~21 June in 1999; ~10 July in 2000; and ~26 July in 2001), however, one would still expect to find evidence of nesting either through territorial behaviour, incubation, or young in, or near, the nest. If we assume that nesting attempts in all 3 years were about the same, then it would appear that nest failure occurred in late incubation or early chick rearing. At an interior area nest outside the study area, a pair of birds was found to be incubating eggs during the 3rd week in July. This is considered a very late date as falcons at this latitude usually hatch in the first week of July. A visit a week later revealed that both the eggs and birds were gone. At a coastal nest, very small falcon chicks (probably < 1 week old) were seen in the last week of July, about 2–3 weeks behind schedule. Something may be interfering with the birds' ability to lay and incubate eggs or raise young, but this remains unclear. Due to the remote nature of all of the nests, human disturbance is not likely a factor. Future surveys will include collection of any unviable eggs for pesticide analysis, as well as information on prey selection among interior peregrines. If resources permit, coastal sites will also be revisited, although there appears to be less cause for concern in that habitat. It is important to continue monitoring peregrines in Labrador to determine whether the recent decreases actually represent a declining trend in this population.

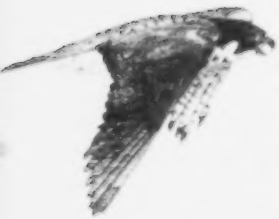
Table 12. Comparison of Peregrine Falcon nesting effort at the same 20 sites in the interior of Labrador, 1999–2001.

Year	1999	2000	2001
Sites checked	20	20	20
Sites with birds	16	2	6
Successful/territorial	15	2	3

Raptor trends in the Northwest Territories and Nunavut: a Peregrine Falcon case study

✠S. Carrière[1,6], D. Abernethy[1], M. Bradley[2], R.G. Bromley[3], S.B. Matthews[1], J. Obst[4], and M. Setterington[5]

[1] Wildlife and Fisheries Division, Dept. of Resources, Wildlife & Economic Development, Gov. NWT, Yellowknife, NT X1A 3S8; [2] Wood Buffalo National Park, Fort Smith, NT X0E 0P0; [3] Whole Arctic Consulting., Yellowknife, NT X1A 2N8; [4] Box 1888, Yellowknife, NT X1A 2P4; [5] Dept. of Sustainable Development, Gov. Nunavut, Arviat, NU X0C 0E0. [6] Corresponding author: Suzanne_Carriere@gov.nt.ca



Randyl Sruba © OMNR

Monitoring wildlife populations north of the 60th parallel is a notoriously expensive activity, and surveys of northern raptor populations are no exception. Because of this, less than 10% of Nunavut and the Northwest Territories have been surveyed for raptors (Fyfe 1969, Bromley 1988, Rowell *et al.* in press) and volunteers traveling or working in remote areas continue to provide invaluable information on raptor sites that were never documented before.

Despite high costs, aerial surveys of raptor est sites have been performed almost an - nually in at least one area of the Northwest Territories or Nunavut since the 1960s, and additional information on nest sites has been opportunistically gathered since the 1940s (Fig. 29).

NWT/NU Raptor Database

Many species of raptors are philopatric (i.e., they use the same nest sites or cliffs year after year). Such predictable use of sites allows us to study trends in raptor populations by comparing past and present information on the use of known nesting areas. In the early 1980s, raptor biologists from the Government of the Northwest Territories (then including Nunavut) expanded on previous work done by the Canadian Wildlife Service and established a protocol to preserve valuable historical data on northern raptor nests and to systematically record new data (Fyfe *et al.* 1976, Bromley 1988, Shank 1997). The NWT/NU Raptor Database (NNRD), as it is known, holds all of the data used in many status and trend studies, particularly on the Peregrine Falcon (*Falco peregrinus*). Some of these studies are summarized below.

Peregrine Falcons in Northern Surveys

Peregrine Falcon numbers had declined noticeably by 1970, principally due to the effects of DDT/DDE, and production was dramatically reduced (Kiff 1988). Few experts provide historical estimates of the number of northern pairs or active eyries prior to 1965, and these estimates ranged from 3500 to more than 7000 (Kiff 1988).

In 1965, Fyfe (*in* Enderson *et al.* 1995) estimated that at least 196 historical nesting sites of Peregrine Falcons were recorded in the arctic and sub-arctic regions of North America. The NNRD has historical records for one-quarter (49) of these sites in the Northwest Territories and Nunavut. Each newly described raptor site is given a unique number so that survey efforts spanning decades can be linked to reveal the history of visits and pair occupancy at each location. The number of Peregrine Falcon nesting sites added annually to the NNRD reflects changes in survey intensity and geographic scope across the Northwest Territories and Nunavut, not necessarily changes in northern populations of Peregrine Falcons. Population change is best examined within individual survey efforts, on defined study areas and with consistent methodology and personnel. These intensive survey efforts (Fig. 29) were initiated for various reasons, including:

(1) concerns over the levels of organochlorine residues in northern Peregrine Falcon (Enderson and Berger 1968, Calef and Heard 1979),
(2) need for baseline surveys of all raptor species prior to, or during, large-scale resource developments (Bromley and Matthews 1988, Matthews 1989),
(3) concerns over the status of Gyrfalcons (*Falco rusticolus*) due to increased interests in selling juvenile Gyrfalcons on the world falconry market (Bromley and McLean 1986), or
(4) future creation of a protected area (Shank 1995).

Despite the original intent of surveys, detailed information on Peregrine Falcon nests was collected at every opportunity.

Trends in Peregrine Falcon populations

Within specific study areas, aerial survey protocols usually involve finding and observing all "occupied" sites (those used by a pair, or an individual) during the peak in the breeding season from mid-June to late-July. Sites with young present are called "productive". Few attempts are made to land and verify the information gathered from aircraft, so some sites actually occupied by birds can be missed. Because Peregrine Falcon pairs do not construct any nest structure but use bare ledges or stick nests borrowed from other species, sites were "known" only after pairs were seen nesting there (Johnstone 1999). Cliffs in good peregrine habitat may be visited during a survey but unless a pair was using it at the time, previous uses were difficult to detect. These types of error are usually consistent between surveys, so year-to-year trends in site occupancy can still be studied (Bromley and Matthews 1988). We make the assumption that declines in Peregrine Falcon breeding populations can be inferred when previously occupied sites are consistently found unoccupied in subsequent surveys. Increases in

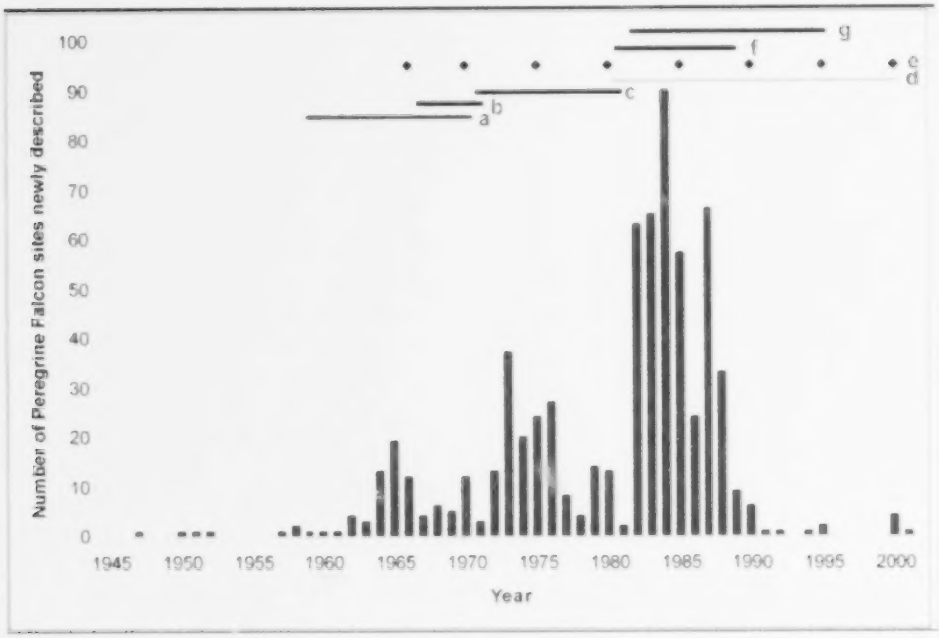


Figure 29. Survey history and the number of unique nesting sites described in the NWT/Nunavut Raptor Database since 1947.

(a) Thelon River surveys (1957-69) – Kuyt 1980. (b) Mackenzie River Valley CWS surveys 1960s –Fyfe 1969. (c) CWS surveys (1970s): Mackenzie River Valley - Fyfe *et al.* 1976., Bromley and Matthews 1988; Thelon River – Armbruster and Russell 1975; Central Canadian Arctic – Armbruster et al. 1975; Banks Is. – Bradley 1975; Horton River (1968, 1973, 1975) – Allison and Dick 1975. (d) Rankin Inlet Peregrine Falcon Project (1981-2000) – Court *et al.* 1988, Bradley *et al.* 1997, Abernethy *et al.* in press. (e) Five-year North American Peregrine Falcon Surveys: see all surveys in b-g in addition to Mackenzie Valley (1966, every 5 years from 1970 to 2000) - Matthews and Carrière, in press, Rowell *et al.*, in press (refs. therein); Tuktu Nogait National Park (1988, 1990, 2000) - Obst, in press; Thelon River (1970, 1975, 1985, 1990) – Pelly 1985, Shank 1996; Belcher Is. (1990) – Nishi 1996; (f) GNWT Mackenzie Valley Surveys (1983-91) and Norman Wells Pipeline Raptor Monitoring Program (1980-88) – Bromley and Matthews 1988, Matthews 1989. (g) GNWT Surveys in Central Canadian Arctic (1982-96), Baffin and Keewatin (1978,1982-91, 1995) – Calef and Heard 1979, Bromley and McLean 1986, Bromley 1988, Shank *et al.* 1993, Shank 1995, Shank 1996. Source: NNRD.

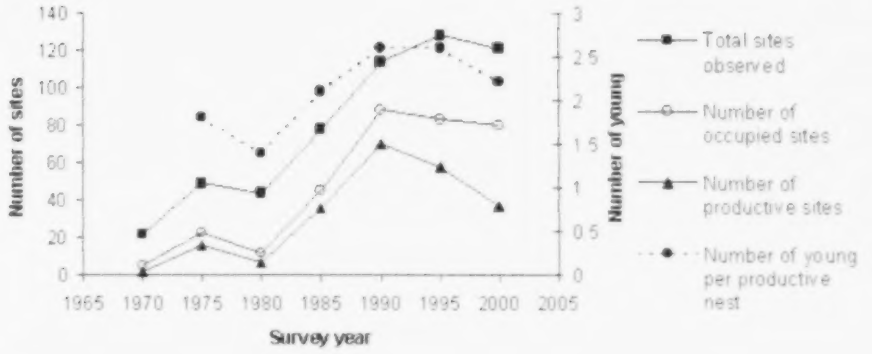

Number of sites
Number of young
Survey year
1965 1970 1975 1980 1985 1990 1995 2000 2005
0 20 40 60 80 100 120 140
0 0.5 1 1.5 2 2.5 3
Total sites observed
Number of occupied sites
Number of productive sites
Number of young per productive nest

Figure 30. Five-year changes in breeding parameters for *anatum* Peregrine Falcons along the Mackenzie River, NT. In the 1970–80s, extra efforts were made to find new sites in previously unsurveyed areas. Source: NNRD. See Enderson et al. 1995, Matthews and Carrière, in press, and analyses in Bromley

breeding populations are inferred if previously occupied sites are consistently found occupied in subsequent surveys and/or newly occupied sites are found in areas previously surveyed.

Taiga - Mackenzie River Valley

This Peregrine Falcon survey covers about 700 km of the 1800 km long Mackenzie River (from the mouth of the Saline River to Inuvik) to a width of 75 km on either side. This section of the river valley has hundreds of cliff faces and wooded cut banks near open water or wetlands that comprise good Peregrine Falcon breeding habitat. The Mackenzie River survey was initiated in the mid–1960s and was performed at least every 5 years until 2000. This population is composed mainly of the *anatum* subspecies of Peregrine Falcon.

In the early 1970s and mid–1980s, new areas were searched every year to find previously unknown nest sites. During the past three decades the number of known nest sites has increased dramatically (Enderson *et al.* 1995; Fig. 30). A year-by-year analysis to correct for the increase in search effort indicated the breeding population started increasing in 1985 (Bromley and Matthews 1988).

The number of occupied sites has not increased since 1990, perhaps because this area reached maximum occupancy for territorial Peregrine Falcon pairs in the early 1990s. Forest fires were more frequent in the study area from 1990–2000 than in any other recorded decade. In 2000, we noted that some sites had been lost due to fire: stick nests previously used by Peregrine Falcon were burned, or slumping and erosion of riverbanks modified the cliff face. Despite habitat changes and presumably some seasonal variability in productivity (Matthews and Carrière, in press), the number of sites occupied by Peregrine Falcons recorded during the last decade in the Mackenzie Valley is the highest since the survey was initiated in the mid–1960s (Fig. 30).

Tundra – Kugluktuk, Hope Bay, and Rankin Inlet

Tundrius Peregrine Falcon sites have been regularly visited as part of raptor surveys done near Kugluktuk and Hope Bay on the mainland south of Victoria Island, NU (Bromley and McLean 1986, Shank *et al.* 1993). These areas have numerous cliffs 10–40 m high dispersed in vegetated tundra. Approximately the same areas were surveyed every year from 1982–1996 (Shank *et al.* 1993). The Rankin Inlet Peregrine Falcon Project, on the west coast of Hudson Bay, is one of the longest raptor monitoring programs in North America. The 450 km^2 project area has low rolling hills with outcrops of up to 53 m in height amongst numerous tundra lakes and ponds (Court 1986).

The last Kugluktuk survey, performed in 1996, showed the largest number of occupied sites ever recorded in that area (Fig. 31). Breeding populations in Kugluktuk, Hope Bay, and, to some extent, in Rankin Inlet showed an upward trend in occupancy in the mid–1980s. In Hope Bay and Rankin Inlet, this trend peaked in the 1990s, suggesting that, as in the Mackenzie Valley, Peregrine Falcons may be at carrying capacity for nest sites in these study areas.

Anatum and *tundrius* Peregrine Falcon populations breeding north of the 60th parallel in Canada appear to have been at their lowest levels in the 1970s. Surveys of migrant falcons coming from the Arctic also showed that these populations declined through the 1960s and '70s (Mueller *et al.* 1988), followed by a recovery initiated in the 1980s (Ward *et al.* 1988). It is not known if northern populations of both subspecies have reached numbers similar to those before the mid-century collapse. Today, data from those few northern areas intensively surveyed suggest that those Peregrine Falcon populations may be near or at maximum occupancy of nest sites. However, the Arctic and sub-arctic are harsh places to nest: large annual variations in weather, food supply, and habitat quality in fire-prone areas appear to be the norm (Bradley *et al.* 1997, see unusual diet in Bradley and Oliphant 1991). These contribute to annual variations in breeding success for northern Peregrine Falcons (Bradley *et al.* 1997, Matthews and Carrière, in press). Furthermore, some areas occupied by nesting falcons in the Northwest Territories and Nunavut are experiencing an increase in disturbance through cabin building, recreational use, and resource exploration and development. Finally, important changes in climate are occurring within the Mackenzie Valley, and similar changes are seemingly happening throughout the central Arctic (IPCC 2001, Serreze *et al.* 2000). These changes will be complex, influencing both the prey populations and the habitat of the peregrine, and the extent of their effect is currently unpredictable.

Future surveys, supplemented by additional information gathered by volunteers, will contribute to our understanding of how northern falcon populations will cope with both natural and human-induced changes in their breeding habitat.

References

Abernethy, D., J. Hunter, and G. Court. In prep. *The 2000 Peregrine Falcon Survey at Rankin Inlet, Nunavut. In* "The 2000 Canadian Peregrine Falcon Survey" (P. Rowell, G.L. Holroyd, and U. Banasch, eds.). The Journal of Raptor Research.

Allison, L. and G. Dick. 1975. *Horton River, Northwest Territories. In* "The 1975 North American Peregrine Falcon survey." (R.W. Fyfe, S.A. Temple, and T.J. Cade., eds.). Can. Field-Nat. 90:228-273.

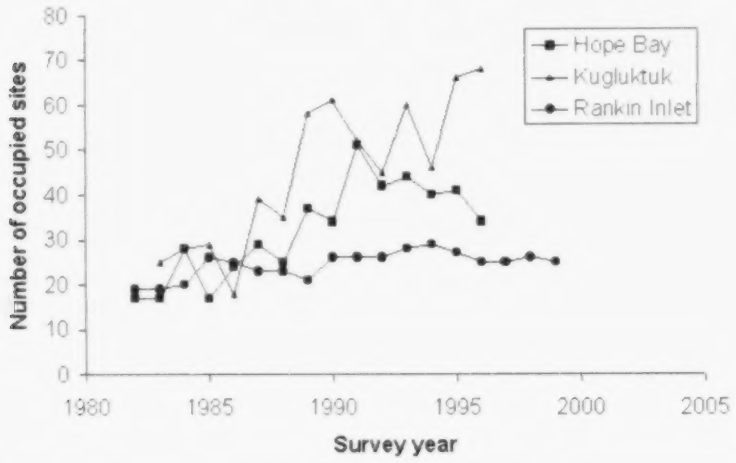


Figure 31. Changes in number of sites occupied by *tundrius* Peregrine Falcons near Hope Bay, Kugluktuk and Rankin Inlet, NU. Sources: Hope and Kugluktuk: Shank *et al.* 1993 (1982-1991), Shank 1996, NNRD (1992-1996); Rankin Inlet: Court *et al.* 1988 (1981-1986), NNRD, R. Johnstone, D. Abernethy and M. Setterington , unpublished data (1987-2000).

© Elaine Dickson

Armbruster, H. and T. Russell. 1975. *Thelon River and Interior Barrens, Northwest Territories. In* "The 1975 North American Peregrine Falcon survey" (R.W. Fyfe, S.A. Temple, and T.J. Cade, eds.). Can. Field-Nat. 90:228-273.

Armbruster, H., T. Russell, T. Barry, and G. Beyersbergen. 1975. *Central Arctic Coast, Northwest Territories. In* "The 1975 North American Peregrine Falcon survey" (R.W. Fyfe, S.A. Temple, and T.J. Cade, eds.). Can. Field-Nat. 90:228-273.

Bradley, S. 1975. *Banks Island. In* "The 1975 North American Peregrine Falcon survey" (R.W. Fyfe, S.A. Tempie, and T.J. Cade, eds.). Can. Field-Nat. 90:228-273.

Bradley, M., R. Johnstone, G. Court, and T. Duncan. 1997. *Influence of weather on breeding success of Peregrine Falcons in the Arctic*. Auk 114:786-791.

Bradley, M. and L.W. Oliphant. 1991. *The diet of Peregrine Falcons in Rankin Inlet, N.W.T.: An unusually high proportion of mammalian prey*. Condor 93:193-197.

Bromley R.G. 1988. *Status of Peregrine Falcons in the Kitikmeot, Baffin, and Keewatin regions, Northwest Territories, 1982-1985*. Pp. 51-58 *in* "Peregrine Falcon populations: their management and recovery" (T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds.). The Peregrine Fund, Boise, ID.

Bromley, M. 1992. *Updated Status Report on the Tundra Peregrine Falcon,* Falco peregrinus tundrius, *in Canada*. Committee on the Status of Endangered Wildlife in Canada. 26 pp.

Bromley, R.G. and S.B. Matthews. 1988. *Status of the Peregrine Falcon in the Mackenzie River Valley, Northwest Territories, 1969-1985*. Pp. 59-63 *in* "Peregrine Falcon populations: their management and recovery" (T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds.). The Peregrine Fund, Boise, ID.

Bromley, R.G. and B.D. McLean. 1986. *Raptor surveys in the Kitikmeot and Baffin Regions, Northwest Territories, 1983 and 1984*. Department of Renewable Resources, Government of the Northwest Territories, File Report No. 65, 63 pp.

Calef, G.W. and D.C. Heard. 1979. *Reproductive success of Peregrine Falcons and other raptors at Wager Bay and Melville Peninsula, Northwest Territories*. Auk 96: 662-674.

Court, G.S. 1986. *Some aspects of the reproductive biology of Tundra Peregrien Falcons*. M.Sc. Thesis presented to the University of Alberta, Department of Zoology.

Court, G.S., D.M. Bradley, C.C. Gates. 1988. *The population biology of Peregrine Falcons* (Falco tperegrinus tundrius) *in the Keewatin District of the Northwest Territories, Canada*. Pp. 729-739 *in* "Peregrine Falcon populations: their management and recovery" (T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds.) The Peregrine Fund, Boise, ID.

Enderson, J.H. and D.D. Berger. 1968. *Chlorinated hydrocarbon residues in peregrines and their prey species from northern Canada*. Condor 70:149-153.

Enderson, J.H., W. Hienrich, L. Kiff, and C.M. White. 1995. *Population changes in North American peregrines*. Trans. of the 60th NA Wild. and Nat. Res. Conf.: 142-161.

Fyfe, R.W. 1969. *The Peregrine Falcon in northern Canada*. Pp. 101-114 *in* "Peregrine Falcon populations: their biology and decline" (J.J. Hickey, ed.). Univ. Wisconsin Press, Madison, WI.

Fyfe, R.W., S.A. Temple, and T.J. Cade. 1976. *The 1975 North American Peregrine Falcon survey*. Can. Field-Nat. 90:228-273.

Intergovernmental Panel on Climate Change, Working Group I. 2001. *Summary for policymakers: The third assessment report: Climate Change Research*. 20 pp.

Johnstone, R.M. 1999. *Updated COSEWIC Status Report on the* Anatum *Peregrine Falcon,* Falco peregrinus anatum. Committee on the Status of Endangered Wildlife in Canada. 42 pp.

Kiff, L.F. 1988. *Changes in the status of the peregrine in North America: an overview*. Pp. 123-139 *in* "Peregrine Falcon populations: their management and recovery" (T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds.). The Peregrine Fund, Boise, ID.

Kuyt, E. 1980. *Distribution and breeding of raptors in the Thelon River area, Northwest Territories, 1957-1969*. Can. Field-Nat. 94:121-130.

Matthews, S.B. 1989. *Norman Wells pipeline project raptor monitoring program 1980-1988*. Department of Renewable Resources, Government of the Northwest Territories. File Report No. 82. 46 pp.

Matthews, S.B. and S. Carrière. in press. *The 2000 Mackenzie Valley, Northwest Territories, Peregrine Falcon Survey. In* "The 2000 Canadian Peregrine Falcon Survey" (P. Rowell, G.L. Holroyd, and U. Banasch, eds.). Occasional Paper Series, Canadian Wildlife Service, Ottawa.

Mueller, H.C., D.D. Berger, and G. Allez. 1988. *Population trends in migrating peregrines at Cadar Graves, Wisconsin, 1939-1985*. Pp. 497-506 *in* "Peregrine Falcon populations: their management and recovery" (T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds.). The Peregrine Fund, Boise, ID.

Nishi, J. 1996. *Belcher Islands. In* "The 1990 Canadian Peregrine Falcon (Falco peregrinus) Survey" (G.L. Holroyd and U. Banasch, eds.). J. Raptor Res. 30:145-156.

Obst, J. In press. *The 2000 Peregrine Falcon Survey in Tuktu Nogait National Park, NWT. In* "The 2000 Canadian Peregrine Falcon Survey" (P. Rowell, G.L. Holroyd, and U. Banasch, eds.). Occasional Paper Series, Canadian Wildlife Service, Ottawa.

Pelly, D.F. 1985. *A naturalist on the Thelon River – Peregrine Falcon Report '85*. Report to Government of the Northwest Territories, 33 pp.

Rowell, P., G.L. Holroyd, and U. Banasch (eds.). In press. *The 2000 Canadian Peregrine Falcon Survey*. Occasional Paper Series, Canadian Wildlife Service, Ottawa.

Serreze, M.C., J.E. Walsh, F.S. Chapin III, T. Osterkamp, M. Dyurgerov, V. Romanovsky, W.C. Oechel, J. Morison, T. Zhang, and R.G. Barry. 2000. *Observational evidence of recent change in the northern high-latitude environment*. Climate Change 46:159-207.

Shank, C.C. 1995. *Raptor survey of the Rasmussen Lowlands – 1995*. Unpublished report, Government of the Northwest Territories, Yellowknife, NT. 5 pp.

Shank, C.C. 1996. *Central Arctic Raptor Surveys*. *Unpublished report*. Government of the Northwest Territories, Yellowknife, NT. 4 pp.

Shank, C.C. 1997. *The Northwest Territories' system of raptor data collection and storage*. Department of Resources, Wildlife & Economic Development, Manuscript report No. 102.

Shank, C., R.G. Bromley, and K.G. Poole. 1993. *Increase in breeding population of Tundra Peregrine Falcons in the Central Canadian Arctic*. Wilson Bull. 105:188-190.

Ward, E.P., K. Titus, W.S. Seegar, M.A. Yates and M.R. Fuller. 1988. *Autumn migrations of Peregrine Falcons at Assateague Island, Maryland/Virginia, 1970-1984.* Pp 485-496 in "Peregrine Falcon populations: their management and recovery" (T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds.). The Peregrine Fund, Boise, ID.

Are northern raptor populations signaling a new collapse?

✠D. Mossop, Biodiversity Assessment and Monitoring Project, Yukon College, Whitehorse, Yukon Y1A 5H5; dmossop@yukoncollege.yk.ca

Sitting as they do at the top of the food-chain, birds of prey are recognized as powerful indicator species of ecosystem health. The demise of the Peregrine Falcon (*Falco peregrinus*) in the 1960s was the impetus that initiated population monitoring of several raptor species and has now resulted in valuable long-term databases at several locations across Canada. In the Yukon Territory a 30-year series of population data exists for five key raptor species maintained at Yukon College as part of its 'Biodiversity Assessment and Monitoring Project'.

Peregrine Falcon nesting populations in the Yukon are surveyed every five years, in part to fulfill the national monitoring stipulated in the Canadian Peregrine Recovery Plan (Bromley *et al.* 1988). By the year 2000, these data suggested a possible collapse in productivity (Mossop 2000). As a result, a follow-up survey was conducted in 2001 on a sub-set of the territory-wide survey. The objective was to collect more detailed data through intensive single visits to nesting sites in the core of the best-known populations to try to shed light on possible environmental effects on productivity not detected by the broader survey.

The findings in 2001 agreed quite closely with those of 2000 (Table 13) with about 20% of the sites showing no evidence of breeding adults at all. This occupancy rate is about 6% below the long-term average. The production of young is cause for more concern. As in 2000, about 60% of all sites had no young, with only 50% of the sites occupied by breeding pairs being productive (i.e. having young to approximately fledging age; Fig. 32).

Our preliminary results suggest a correlation with the "age" of the site. It seems to be the sites (and perhaps pairs) with the longest history in the population that are showing productivity problems. If older adults are implicated, it could imply a building concentration of a chemical contaminant, raising the specter of the disaster of the '60s. A secondary suggestion relates to the age of the young in the nests. Although based on small samples, it appears that nesting dates are later, and the least healthy young are found in nests with very late hatch dates. Future monitoring should be able to clarify this.

Though overall production in the Yukon Peregrine population may not be in a catastrophic "collapse" there are other troubling signs. Chief among these are the findings of others monitoring *anatum* Peregrines in the northern limits of their range. In Labrador, surveys suggest a decline of almost 80% in the last three years (Brazil 2001). American Kestrels (*Falco sparverius*) in the Yukon have shown an 80% decline in occupancy of nest boxes over the last 5 years. This might indicate that raptors in general warrant concern.

Because of these early signs of trouble, it is imperative that monitoring continue. The 2001 survey was carried out because past

Table 13. Summary of results, Yukon Territory Peregrine Falcon Survey, 2001.

Sub population	year	no. checked	no. occupied	no. productive	young/ productive pair
Yukon River	2001	47	37 (77%)	17 (35.4%)	2.4 + 0.9
	2000	53	43 (81%)	22 (41.5%)	3.1+ 1.0
Peel River	2001	8	7 (88%)	5 (62%)	?
(whole Peel)	2000	31	22 (70%)	12 (39%)	1.2 + 0.6
TOTAL	2001	55	44 (80%)	22 (40%)	2.4+0.9
	2000	84	65 (77%)	34 (41%)	2.3 + 1.5

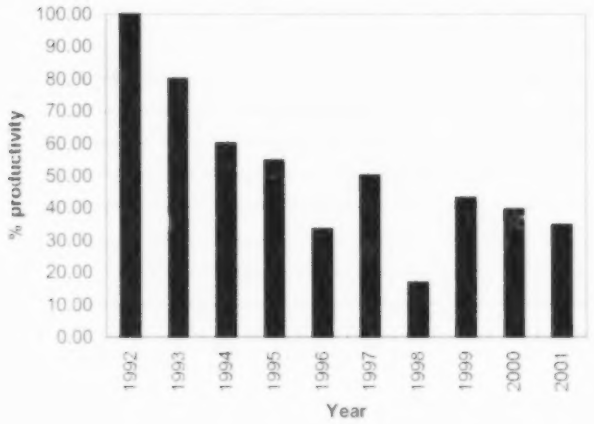


Figure 32. Apparent decline in productivity of Yukon Peregrine Falcons over the last 10 Years.

experience has proven that the peregrine can provide early warning of environmental contamination (Mossop 2001). There is also strong evidence they can serve as indicators for issues like climate change. Given the excellent long-term database for the species, a strong pitch is being made in the Yukon to continue monitoring its performance and to assign this research to graduate-level scholarly attention. A partnership between Yukon College and the University of Northern BC has been forged to begin that work.

References

Brazil, J. 2001. *The 2001 peregrine falcon (Falco peregrinus) survey in interior Labrador.* Inland Fish and Wildlife Div., Newfoundland and Labrador report to the Canadian Peregrine Falcon Recovery Team, Halifax, 2001.

Bromley, R., R. Fyfe, G. Erickson, G.L. Holroyd, D. Mossop, B. Munro, R. Nero, C. Shank, and T. Wiens. *1988. Anatum Peregrine Falcon Recovery Plan.* National Recovery Plan No. 2. Recovery of Nationally Endangered Wildlife, Canadian Wildlife Service, 43 pp.

Mossop, D. 2000. *Population status of the Peregrine Falcon in the Yukon Territory, 2000.* Northern Research Institute, Yukon College, Whitehorse. 26 pp.

Mossop, D. 2001. *Investigation of declining productivity in Yukon Peregrine Falcon.* Proposal, Feb. 2001.

An overview of recovery and trends in Bay of Fundy Peregrine Falcons

Diane L. Amirault, CWS Atlantic Region, Sackville, NB E4L 1G6; Diane.Amirault@ec.gc.ca

Documentation of the historical abundance of Peregrine Falcons in the Bay of Fundy is incomplete at best. A historical account of the Peregrine Falcon in the Maritimes (Stocek and Pearce 1978) indicated that the falcon had never been a common nesting species here. The same report cited published and unpublished reports of 13 eyries, most of which occurred in the Upper Bay of Fundy. It is tempting, then, to establish the historical nesting population estimate of falcons at 13 pairs. However, as there is insufficient evidence to confirm that all nest sites were active in any given year, this number likely does not represent the true nesting population. It is also possible that population levels were depressed due to shooting and harassment at the time when the first population estimates were established. There is also documented evidence that young Peregrine Falcons were taken from nest sites for falconry (M. Elderkin, pers. comm.).

The widespread demise of the Peregrine Falcon across its breeding range also extended to the Bay of Fundy. The last documented nesting pair prior to extirpation from the region occurred at Cape d'Or, Nova Scotia in 1955 (Sam *et al.* 1994). After 1955, observations of the Peregrine Falcon were restricted to transient individuals seen during migration. The number of transient Peregrine Falcons reported per year between 1964 and 1975 ranged from one to 24 (Stocek and Pearce 1978).

The first coordinated survey to determine population levels in Canada was organized in 1970 (Holroyd and Banasch 1996). Since then, surveys have been repeated every five years to establish trends. In addition to the five-year surveys, annual efforts have been undertaken at known nest sites to confirm the presence of nesting adults and to determine productivity (defined as the number of chicks fledged per pair). Regular searches for new nest sites have been conducted in Nova Scotia by the provincial Department of Natural Resources. Other contributors to

Table 14. Number of young Peregrine Falcons hacked in the Bay of Fundy, 1982–1991.

Site	Number of Young Released
New Brunswick	
Fundy National Park	55
Quaco Head	14
Nova Scotia	
Cape d'Or	34
Blomidon Prov Park	37
Five Islands Prov Park	38
Total	178

the documentation, monitoring and conservation of the Peregrine Falcon in the Bay of Fundy are Parks Canada Agency (Fundy National Park) and the New Brunswick Department of Natural Resources and Energy. Naturalist observations add to the information compiled and help to provide a more complete picture of progress towards species recovery in the region. Reports of nesting pairs are investigated when new information is obtained.

The first three surveys (1970, 1975 and 1980) confirmed that Peregrine Falcons were no longer nesting in the potential habitats of the Bay of Fundy. Shortly after the use of DDT was banned in the late 1960s and early 1970s (Baril *et al.* 1989), a peregrine release program was initiated to reintroduce falcons to those regions of Canada where they had been extirpated. The Bay of Fundy reintroduction program was established in 1982, and within nine years (1982–1991) a total of 178 young falcons were hacked from five sites in Nova Scotia and New Brunswick (Table 14).

The release program for the Peregrine Falcon in the Bay of Fundy proved to be an overwhelming success. As early as 1985, territorial pairs were observed in suitable nesting habitat, and all of these individuals possessed the red metal band indicating that these were released captive-reared birds. The first confirmed nesting and production of young following the release program occurred in 1989 when three pairs nested in the province of New Brunswick, producing five young. Since that time, the Bay of Fundy Peregrine Falcon population has shown characteristics indicative of a well re-established population. Natural replacement of red-banded birds with unbanded individuals has occurred indicating that the population is being sustained without the additional release of captive reared birds. Productivity data collected at monitored nests and from observations of naturalists indicates that, in almost all years, the number of young produced per territorial pair has consistently exceeded the 1.0 to 1.5 rate estimated to be required to maintain a stable population (Newton 1979 *in* Holroyd and Banasch 1996). Between 1989–2001, a minimum of 163 young Peregrine Falcons are known to have fledged. There is also information indicating that toxic chemicals in the environment no longer pose a risk to Bay of Fundy peregrines. Unhatched, addled eggs have been recovered from two sites in New Brunswick for toxics analysis, and these eggs have been relatively free of the contaminants that cause reproductive failure (L. Shutt, unpubl. data).

Recovery population targets for Zone 1, which includes the Maritimes and parts of Quebec and Labrador (Erickson *et al.* 1988), were met in 1990. Population numbers have now exceeded the target numbers identified for achieving species recovery, and increased dramatically between 1985 and 1990 (Table 15). Due to logistical constraints, the 1995 survey did not include an exhaustive search of all known habitat, and results should, therefore, be considered as a minimum number of nesting pairs. Annual population counts between 1990 and 1994 showed a stable number of territorial pairs which then increased between 1995 and 2000 as a result of population expansion in Nova Scotia. The first confirmation of nesting in the province of Nova Scotia occurred in 1995.

The number of territorial Peregrine Falcon pairs reported annually has not yet reached a plateau (Fig. 33). Population surveys conducted in 2001 provide a current popula-

Table 15. Total number of territorial pairs in the Bay of Fundy during nation-wide survey years, 1970–2000 .

	1970	1975	1980	1985	1990	1995	2000
New Brunswick	0	0	0	1	7	5	5
Nova Scotia	0	0	0	0	0	1	5
Total	0	0	0	1	7	6	10

tion count of 11 territorial pairs, the highest count documented to date.

The success of Peregrine Falcon recovery is closely linked to the impressive numbers of Semipalmated Sandpipers (*Calidris pusilla*) and other shorebirds (Hicklin 1987; Gratto-Trevor 1992) which use the Bay of Fundy as a staging area from late summer to early fall to accumulate fat reserves that fuel their southward migration. Peregrines are regularly observed foraging at major shorebird roosts at several sites in the Upper Bay of Fundy (Campbell 1999).

Over the next few years, it will be interesting to document whether or not, when, and at what level, peak population numbers are achieved. Monitoring of the Bay of Fundy Peregrine Falcon population will continue in order to confirm productivity levels and also to identify the effectiveness of protection measures and the need for additional conservation. Current research questions being pursued are related to identifying the genetic parameters of re-established *anatum* Peregrine Falcon populations.

References

Baril, A., J.E. Elliott, J.D. Somers and G. Erickson. 1989. *Contaminants in the prey of Peregrine Falcon in Canada.* Technical Report Series No. 62. Canadian Wildlife Service, Ottawa.

Campbell, A. 1999. *Predation success of Peregrine Falcons (Falco peregrinus) and Merlins (Falco columbarius) on the Semipalmated Sandpiper (Calidris pusilla) at high and low flock densities in the Upper Bay of Fundy.* Unpubl. B.Sc. thesis, Mount Allison University, Sackville, N.B. 39 pp.

Erickson, G., R. Fyfe, R. Bromley, G.L. Holroyd, D. Mossop, B. Munro, R. Nero, C. Shank and T. Wiens. 1988. Anatum *Peregrine Falcon Recovery Plan.* Canadian Wildlife Service publication. 52 pp.

Gratto-Trevor, C.L. 1992. *Semipalmated Sandpiper (Calidris pusilla) in* "The Birds of North America, No. 6" (A. Poole, P. Stettenheim, and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia and the American Ornithologists' Union, Washington, DC.

Hicklin, P.W. 1987. *The migration of shorebirds in the Bay of Fundy.* Wilson Bull. 99(4):540-570.

Holroyd, G.L. and U. Banasch. 1996. *The 1990 Canadian Peregrine Falcon (Falco peregrinus) Survey.* J. Raptor Res. 30(3): 145-156.

Sam, D., S. Boates, P. Austin-Smith, B. Johnson and G. Dickie. 1994. *Status of the Peregrine Falcon (anatum) in Nova Scotia: A synopsis of recovery efforts (September, 1994).* Unpublished Nova Scotia Department of Natural Resources Report. 6 pp.

Stocek, R.F. and P.A. Pearce. 1978. *The peregrine falcon in the Maritime Provinces.* Canadian Wildlife Service, Wildlife Toxicology Division. Manuscript Report No. 36. 10 pp.

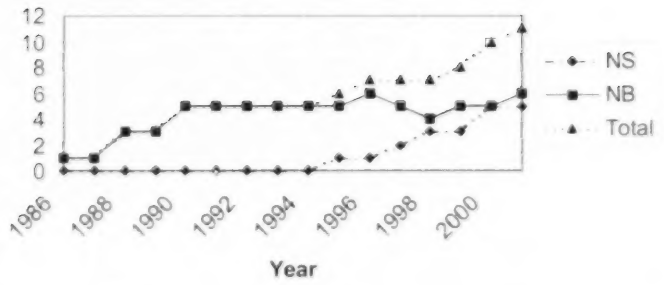


Figure 33. Number of Peregrine Falcon territorial pairs in the Bay of Fundy, 1986-2001.

Menu of volunteer-based ornithological programs in Canada

This list includes only projects that document species abundance and population trends. For a more complete listing of programs that monitor landbirds, you may obtain a copy of the *Canadian Landbird Monitoring Strategy* from: Connie Downes, Migratory Bird Populations Division, National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Ottawa K1A 0H3; 613-998-0490 tel; 613-998-0458 fax; Connie.Downes@ec.gc.ca.

Distributional Studies

Bird banding

Bird Banding Office,
National Wildlife Research Centre,
Canadian Wildlife Service, Carleton University
Ottawa, ON K1A 0H3
tel (613) 998-0524, fax (613) 998-0458
email: bbo_cws@ec.gc.ca
http://www.cws-scf.ec.gc.ca/nwrc-cnrf/index_e.cfm

Studies of Abundance and Population Trends

Breeding Bird Survey (BBS)

Migratory Bird Populations Division,
National Wildlife Research Centre,
Canadian Wildlife Service, Carleton University
Ottawa, ON K1A 0H3
tel (613) 998-0490, fax (613) 998-0458
email: Connie.Downes@ec.gc.ca
http://www.cws-scf.ec.gc.ca/nwrc-cnrf/migb/01_1_2_e.cfm

Canadian Lakes Loon Survey (CLLS)

Bird Studies Canada
P.O. Box 160
Port Rowan, ON N0E 1M0
tel (519) 586-3531, fax (519) 586-3532
email: aqsurvey@bsc-eoc.org
http://www.bsc-eoc.org/cllsmain.html

Checklist programs

Alberta Bird Survey Checklist
Federation of Alberta Naturalists
Box 1472
Edmonton, AB T5J 2N5
tel (780) 453-8629
info@fanweb.ca
http://www.fanweb.ca/

NWT/Nunavut Bird Checklist Survey
Canadian Wildlife Service
Suite 301, 5204-50th Ave.
Yellowknife, NT X1A 1E2
tel (867) 669-4771, fax (867) 873-8185
email:NWTChecklist@ec.gc.ca
http://www.NWTChecklist.com
http://www.mb.ec.gc.ca/nature/migratorybirds/nwtbcs/index.en.html

Étude des Populations d'Oiseaux du Québec (EPOQ)
Jacques Larivée
EPOQ
194 Ouellet
Rimouski, PQ G5L 4R5
tel (418) 722-6509 (H) (418) 723-1880 (W)
email: jacques.larive@cgocable.ca
http://www.oiseauxqc.org/epoq.html

Christmas Bird Counts (CBC)

Contact your local naturalist club for the name of the CBC coordinator in your area, or write:

Geoff LeBaron
National Audubon Society
700 Broadway
New York, NY 10003
tel (212) 979-3000
email: glebaron@audubon.org
http://birdsource.cornell.edu/cbc/

Forest Bird Monitoring Program (FBMP)

Canadian Wildlife Service
49 Camelot Drive
Nepean, ON K1A 0H3
tel (613) 941-5913, fax (613) 952-9027
email: FBMP@ec.gc.ca
http://www.on.ec.gc.ca/wildlife/wild-watchers/watchers99-e.html#fbmp

BC Coastal Waterbird Surveys

Jeanne Roy, Bird Studies Canada
5421 Robertson Road, R.R. # 1
Delta, BC V4K 3N2
tel (604) 940-4696 fax (604) 946-7022
1 (877) 349-2473 (toll free)
email: jeanne.roy@ec.gc.ca

Hawk counts

Hawk Migration Association of North America
Mike Street
73 Hatton Drive
Ancaster, ON L9G 2H5
tel (905) 648-3737 (evenings)
mikestreet@hwcn.org
http://www.hmana.org

Hawkwatches

(i) Ontario:

Bruce Peninsula
Mark Wiercinski
Box 9
Heathcote, ON N0H 1N0
tel (519) 599-3322

Greater Toronto Raptor Watch (Sept.1-Dec.)
(Cranberry Marsh / High Park)
John Barker
27 Horizon Crescent
Scarborough, ON M1T 2G2
tel (416) 291-1598

Doug Lockrey, Cranberry Marsh coordinator
lockrey33@rogers.com
http://www.gtrw.ca/hp/site.htm

Hawk Cliff (Sept.1 - Nov.30)
Hawk Cliff Foundation
P.O. Box 11
Port Stanley ON N5L 1J4
shayredmond@rogers.com
http://www.ezlink.on.ca/~thebrowns/HawkCliff/index.htm

Holiday Beach (Sept.1 - Nov.30).
Bob Hall-Brooks, President
(519) 972-5736
bhall-brooks@cogeco.ca
http://www.hbmo.org/

or Bev Wannick, Canadian Vice-President
bwannick@erca.org

Niagara Peninsula (March 1 - May 15).
Mike Street
73 Hatton Drive
Ancaster, ON L9G 2H5
tel (905) 648-3737 (evenings)
mikestreet@hwcn.org
http://www.hwcn.org/link/niaghawk/index.html

(ii) Alberta:

Calgary Hawkwatch
Wayne Smith
8220 Elbow Drive
Calgary, AB T2V 1K4
tel (403) 255-0052

Alberta Hawkwatch
Peter Sherrington
Eagle Monitoring
R.R. 2
Cochrane, AB T0L 0W0
tel (403) 932-5183
email: psherrin@telusplanet.net

Maritimes Shorebird Survey

Peter Hicklin
Canadian Wildlife Service, Atlantic Region
P.O. Box 6227
Sackville, NB E4L 1G6
tel (506) 364-5042, fax (506) 364-5062,
email: Peter.Hicklin@ec.gc.ca

Great Lakes Marsh Monitoring Program

Bird Studies Canada
P.O. Box 160
Port Rowan, ON N0E 1M0
tel (519) 586-3531, fax (519) 586-3532
email: aqsurvey@bsc-eoc.org
http://www.bsc-eoc.org/mmpmain.html

Migration Monitoring Program (MMP)

Bird Studies Canada
P.O. Box 160
Port Rowan, ON N0E 1M0
tel (519) 586-3531, fax (519) 586-3532
email: generalinfo@bsc-eoc.org
http://www.bsc-eoc.org/national/cmmn.html

Migration Monitoring/Banding Stations:

Rocky Point
David Allinson
3472 Sunheights Drive,
Victoria, BC V9C 3P7
(250) 480 9433 (W); 250-478-0493 (H)
email: goshawk@pacificcoast.net
http://www.islandnet.com/~rpbo/

Vaseux Lake
Dick Cannings, Bird Studies Canada
1330 Debeck Road
S11, C96, RR#1
Naramata, BC V0H 1N0
tel (250) 496-4049
email: dickcannings@shaw.ca

Mackenzie Nature Observatory
Vi Lambie or Cheryl Freeman
c/o Mackenzie Nature Observatory
P.O. Box 1598
Mackenzie, BC V0J 2C0
tel Vi (250) 997-6876 (H)
email: lambie@uniserve.com or
tel Cheryl (250) 997-6927 (H)
email:peeka@uniserve.com

Lesser Slave Lake Bird Observatory
P.O. Box 1076
Slave Lake, AB T0G 2A0
tel (780) 849-7117, cell (780) 805-1355
fax (780) 849-7122
email: birds@lslbo.org
http://www.lslbo.org

Beaverhill Bird Observatory
P.O. Box 1418
Edmonton, AB T5J 2N5
email:charles@ualberta.ca
email: Geoffrey.Holroyd@ec.gc.ca
http://www.beaverhillbirds.com

Inglewood Bird Sanctuary
Doug Collister
3426 Lane Cr. SW
Calgary, AB T3E 5X2
tel (403) 240-1635 (H); (403) 246-2697 (W)
fax (403) 246-2697, email: collis@telusplanet.net

Last Mountain Bird Observatory
Al Smith, Canadian Wildlife Service
Prairie & Northern Region
115 Perimeter Rd.
Saskatoon, SK S7N 0X4
tel (306) 975-4091 (W); fax (306) 975-4089
email: Alan.Smith@ec.gc.ca
http://www.naturesask.com/lmbo.html

Delta Marsh Bird Observatory
Heidi den Haan
R.R. 1, Box 1
Portage la Prairie, MB R1N 3A1
tel (204) 239-4287; fax (204) 239-5950
email: hdenhaan@dmbo.org
http://www.dmbo.org

Thunder Cape Bird Observatory
Nick Escott
133 South Hill St.,
Thunder Bay, ON P7B 3T9
tel (807) 345-7122 (H)
email: ngescott@shaw.ca
http://tbtn.org/tcbotbtn.htm

Whitefish Point Bird Observatory
Jeanette Morss, WPBO
16914 N. Whitefish Point Rd.
Paradise, MI 49768
tel (906) 492-3596; fax (906) 492-3954
email: warbler@jamadots.com
http://www.wpbo.org

Long Point Bird Observatory
Landbird Programs Coordinator
Bird Studies Canada
P.O. Box 160
Port Rowan, ON N0E 1M0
tel (519) 586-3531, fax (519) 586-3532
email: lpbo@bsc-eoc.org
www.bsc-eoc.org/lpbovol.html

Haldimand Bird Observatory
John Miles
tel (519) 587-5223 (H), email: miles@kwic.com
http://www.geocities.com/haldimandbirdobservatory

Toronto Bird Observatory
Lori Nichols
Box 439, 253 College St.,
Toronto, ON M5T 1R5
tel (416) 604-8843 (H)
email: nkhsin@netrover.com

Prince Edward Point Bird Observatory
Eric Machell
P.O. Box 2
Delhi, ON N4B 2W8
tel (519) 582-4738 (H)
email: peptbo@rogers.com
http://www.peptbo.ca/

Innis Point Bird Observatory
Bill Petrie (chair)
P.O. Box 72137, North Kanata Station
Ottawa, ON K2K 2P4
tel (613) 820-8434 (H)
email:wlpetrie@magi.com
http://www.magi.com/~wlpetrie/IPBO.html

Tadoussac
Jacques Ibarzabal
1824 Sainte-Famille
Jonquiere, QC G7X 4Y3
tel (418) 542-2560 (H)
email: jhawk.ibarzabal@sympatico.ca

Fundy Bird Observatory
Brian Dalzell
62 Bancroft Point
Castalia, NB E5G 3C9
tel (506) 662-8650 (H), fax (506) 662-9804
email: dalzell@nbnet.nb.ca
http://personal.nbnet.nb.ca/gmwhale/seabirds.htm

Point Lepreau
Jim Wilson
Saint John Naturalists' Club
2 Neck Rd.
Quispamsis, NB E2G 1L3
tel (506) 847-4506 (H); fax (506) 849-0234
email: jgw@nbnet.nb.ca

Brier Island
Lance Laviolette
R.R. 1
Glen Robertson, ON K0B 1H0
tel (613) 874-2449 (H)
(514) 340-8310 ext. 8495 (W)
email: lance.laviolette@lmco.com

Atlantic Bird Observatory
Phil Taylor or Trina Fitzgerald
Dept.of Biology, Acadia University
Wolfville, NS B0P 1X0
tel (902) 585-1313 (W); fax (902) 585-1059
email: ABO@acadiau.ca
http://landscape.acadiau.ca/abo/index.html

Gros Morne National Park Migration Monitoring Station
Stephen Flemming, Gros Morne National Park
P.O. Box 130
Rocky Harbour, NF A0K 4N0
tel (709) 458-2417; fax (709) 458-2059
email: stephen_flemming@pch.gc.ca

Monitoring Avian Productivity and Survivorship (MAPS)

Standardized constant-effort bird-banding to estimate population size and productivity. Banding permit required. Continent-wide, but limited coverage. Contact your local banding group, or:

Bird Banding Office
National Wildlife Research Centre
Canadian Wildlife Service, Carleton University
Ottawa, ON K1A 0H3
tel (613) 998-0524, fax (613) 998-0458
email: bbo_cws@ec.gc.ca

Or

Institute for Bird Populations
P.O. Box 1346, 11435 S.R.#1, Suite 23
Point Reyes Station, CA 94956
tel (415) 663-1436; fax (415) 663-9482
email: ddesante@birdpop.org
http://www.birdpop.org/maps.htm

Project FeederWatch

Project FeederWatchCoordinator
Bird Studies Canada
P.O. Box 160
Port Rowan, ON N0E 1M0
tel (519) 586-3531; fax (519) 586-3532
email: pfw@bsc-eoc.org

Nest Record Schemes

Compilation of records from individual nests (habitat, clutch size, success, etc.).

British Columbia

Wayne Campbell
B.C. Wild Bird Trust
P.O. Box 6218, Station C
Victoria, BC V8P 5L5
email: rwcampbell@shaw.ca
tel (250) 477-0465

Alberta

Glen Semenchuk
Federation of Alberta Naturalists
11759 Groat Road
Edmonton, Alberta, T5M 3K6
tel (780) 427-8124, fax (780) 422-2663
email: fan@fanweb.ca
http://www.fanweb.ca

Saskatchewan

Glenn Sutter
Curator of Ornithology and Human Ecology
Royal Saskatchewan Museum
2340 Albert St.,
Regina, Saskatchewan, S4P 3V7
tel (306) 787-2859
email: gsutter@royalsaskmuseum.ca

Manitoba (also NWT & Nunavut)

Manitoba Museum of Man and Nature
190 Rupert Avenue
Winnipeg, MB R3B 0N2
tel (204) 956-2830; fax (204) 942-3679
email: info@manitobamuseum.mb.ca

Ontario

George Peck
Royal Ontario Museum
100 Queen's Park
Toronto, Ontario, M5S 2C6
tel (416) 586-5523
email: onrs@rom.on.ca
http://birdsontario.org/onrs-onrsmain.html

Quebec

Michel Gosselin
Canadian Museum of Nature
P.O. Box 3443, Station D
Ottawa, ON K1P 6P4
tel (613) 566-4291; fax (613) 364-4027
email: mgosselin@mus-nature.ca

Maritimes

A.J. (Tony) Erskine
CWS Atlantic Region
P.O. Box 6227
Sackville, NB E4L 1G6
tel (506) 364-5035; fax (506) 364-5062
email: Tony.Erskine@ec.gc.ca

Newfoundland and Labrador Nest Records

John Maunder
The Newfoundland Museum
Box 8700, Duckworth Street
St. John's, NF A1B 4J6
tel (709) 729-5077
email: jmaunder@gov.nf.ca

Bird Trends is published for free distribution by the Canadian Wildlife Service. To save resources, please help us maintain a current mailing list. *Bird Trends* aims to provide:

- feedback to volunteers of ornithological surveys;
- information on trends in Canadian bird populations;
- a menu of volunteer-based ornithological projects in Canada.

Contents may be used without permission with appropriate credit to the source. Additional information may be obtained from: Migratory Birds Conservation Division,
Canadian Wildlife Service, Ottawa, Ontario K1A 0H3, tel (819) 953-4390, fax (819) 994-4445,
email: Judith.Kennedy@ec.gc.ca

Cette publication est également disponible en français sous le titre Tendances chez les oiseaux.

Canada

Environment Canada | Environnement Canada

Canadian Wildlife Service | Service canadien de la faune

Illustrations by Kandyd Szuba from *Forest raptors and their nests in Central Ontario*, Ontario Ministry of Natural Resources, Southcentral Sciences Section Field Guide FG-03, 1998, Queen's Printer for Ontario. Illustrations by Ellaine M. Dickson and David A. Kirk used with permission.